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ABSTRACT

This book is a manual that enables teachers to formulate an effective program of environmental education across multiple grade levels and cultural settings. A section provides tips for using the book, followed by nine chapters dealing with different aspects of developing and implementing an environmental education program. Chapter 1 presents a brief overview of what environmental education is all about. Chapter 2 focuses on developing an environmental education plan by addressing the environmental issues in the community. Chapter 3 discusses how to tailor an environmental education program to fit the needs of the school system and community. Chapter 4 focuses on how children develop intellectually and morally and how to use child development theories to develop a more effective environmental education program. Chapter 5 looks at how to develop an environmental scope and sequence. Chapter 6 focuses on lesson plans, learning styles, learning strategies. Chapter 7 presents methods of creating effective environmental education activities and includes over 50 sample activities. Chapter 8 examines strategies for implementing an environmental education program. Chapter 9 focuses on a variety of formal and informal strategies for evaluating environmental education efforts. An appendix includes additional resources, a bibliography and an index. (MDH)

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ENVIRONMENTAL EDUCATION in the SCHOOLS

Creating a Program that Works!

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ENVIRONMENTAL EDUCATION IN THE SCHOOLS
Creating a Program that Works!

by
JUDY A. BRAUS
DAVID WOOD

LESLIE EICHNER LEFRANC
Design

NANCY MILLER
Desktop Publishing

PEACE CORPS
Information Collection and Exchange

August 1993
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ACKNOWLEDGEMENTS

> *Do what you can, with what you have, where you are.*
>
> —Theodore Roosevelt

We'd like to thank the many friends and colleagues who helped us develop this environmental education manual for Peace Corps.

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Learning Tree; Dr. Martha Monroe, *Environmental Education Consultant;* Dr. Bill Stapp, *Professor, Natural Resources, University of Michigan;* Diane Wood, *Vice-President, Latin American and the Caribbean, World Wildlife Fund.*

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And finally, we'd like to acknowledge all the Peace Corps Volunteers and country staff from around the world who helped us, directly and indirectly, by sharing their views on environmental education and for the work they continually do on behalf of the environment to help make the world a better place for all of us.

Judy Braus — David Wood

Judy Braus — David Wood

TIPS FOR USING THIS BOOK

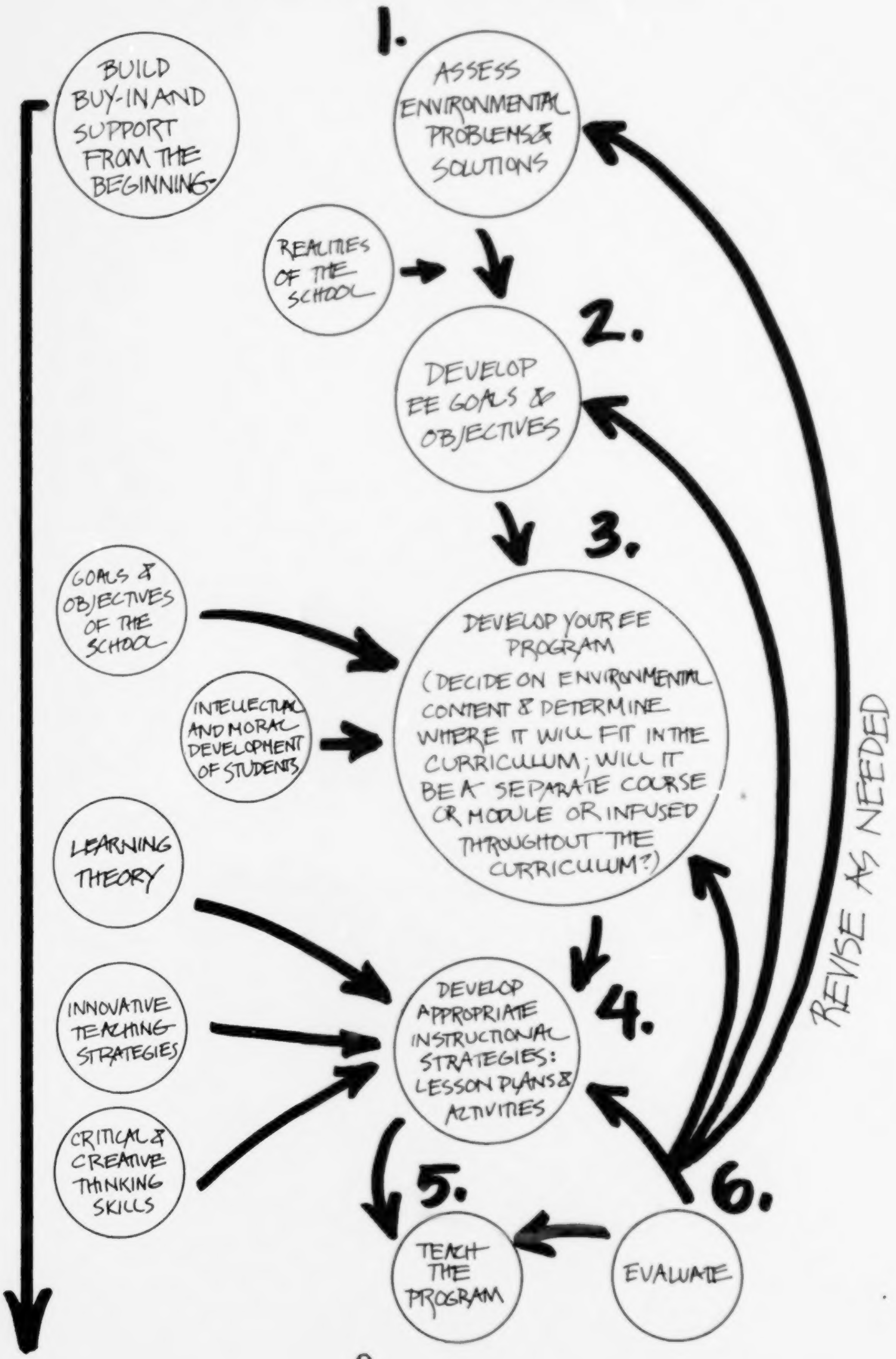
You can't really understand other traditions if you don't understand your own.

—John Searle

As you will see from the Table of Contents, we've divided *Environmental Education in the Schools: Creating a Program That Works!* into nine chapters, with an appendix that includes the bibliography and other information. Each chapter deals with a different aspect of developing and implementing an environmental education program. Although each chapter stands alone, you might want to skim the main subheads in each chapter to decide which parts are most appropriate for your needs.

In general, we encourage you to follow a planning process that begins with looking at the local environmental problems in your community (Chapter 2) and the realities of the school system you will be working with, including the cultural issues that might influence your effectiveness (Chapter 3). We also feel it's important to take the intellectual and moral development of your students into consideration as you develop your program (Chapter 4). As you develop goals and objectives for your environmental education activities, you will be more effective if what you suggest helps enhance the goals and objectives of your school's curriculum (Chapter 5). In addition, we encourage you to try to incorporate innovative teaching strategies, such as creative and critical thinking skills, hands-on discovery, cooperative

DEVELOPING AN EFFECTIVE EE PROGRAM


BUILD BUY-IN AND SUPPORT FROM THE BEGINNING
1.
ASSESS ENVIRONMENTAL PROBLEMS & SOLUTIONS
REALITIES OF THE SCHOOL
2.
DEVELOP EE GOALS & OBJECTIVES
3.
GOALS & OBJECTIVES OF THE SCHOOL
INTELLECTUAL AND MORAL DEVELOPMENT OF STUDENTS
DEVELOP YOUR EE PROGRAM (DECIDE ON ENVIRONMENTAL CONTENT & DETERMINE WHERE IT WILL FIT IN THE CURRICULUM; WILL IT BE A SEPARATE COURSE OR MODULE OR INFUSED THROUGHOUT THE CURRICULUM?)
REVISE AS NEEDED
LEARNING THEORY
INNOVATIVE TEACHING STRATEGIES
CRITICAL & CREATIVE THINKING SKILLS
4.
DEVELOP APPROPRIATE INSTRUCTIONAL STRATEGIES: LESSON PLANS & ACTIVITIES
5.
TEACH THE PROGRAM
6.
EVALUATE

learning, and high level questioning (Chapter 6). We've also included a variety of sample environmental education activities that you can adapt to fit your needs (Chapter 7). And finally, we have included suggestions for ways to build support for your programming ideas (Chapter 8) and develop formal and informal techniques to evaluate your success (Chapter 9).

The visual overview on the left summarizes our recommendations for developing an environmental education course, program, or curriculum.

SUCCESS STORIES

On the page oppposite each Chapter, we've included a brief environmental education success story. Each focuses on the work Volunteers and educators from other organizations are doing around the world to make a difference.

A WORD ABOUT THE ACTIVITIES

Chapter 7 includes a variety of activities that have been reprinted from many sources. The activities are divided into 26 groupings that focus on different topics and different teaching techniques. Each of the 26 categories begins on a right hand page with an introduction that explains the category and the activities contained in the section. Each category is marked at the top with an animal symbol. All of the activities in that section are marked with a smaller version of the animal symbol. Many of the activities are accompanied by a ready-to-copy activity page. Feel free to copy and use these specially marked activity pages. But please make sure to give credit to the source if you use the activity with students or other teachers. (All the credits are listed in the introduction for each activity section.)

Each activity also includes a brief outline of objectives, ages, subjects, and materials. The ages listed vary from activity to activity, depending on their source. Don't feel bound by the grade levels or ages suggested. You'll be able to adapt many of the activities to fit your particular age group and needs.

WHAT'S AT THE END?

The Appendix, on page 461, includes lesson planning models, two sample environmental education frameworks, a sample list of core thinking skills, an overview of Bloom's taxonomy, a sample scope and sequence for environmental ethics, and the goals of curriculum development for environmental education. The Bibliography provides an annotated list of materials that can help you as you develop your environmental education program. And the Index can help you find what you're looking for in this huge book!

INTRODUCTION 1

1 WHAT IS ENVIRONMENTAL EDUCATION
Presents a brief overview of what environmental education is all about, including the goals of environmental education and a look at some of the major issues facing educators. 5

2 PLANNING FOR SUCCESS
Focuses on developing an environmental education plan by addressing the environmental issues in your community and developing effective goals, objectives, and strategies. 15

3 MAKING ENVIRONMENTAL EDUCATION FIT
Discusses how to tailor an environmental education program to fit the needs of your school system, colleagues, and community. 29

4 GETTING TO KNOW YOUR STUDENTS
Focuses on how children develop intellectually and morally and how to use child development theories to develop a more effective environmental education program. 41

5 PUTTING IT ALL TOGETHER
Looks at how to develop an environmental education scope and sequence that meets your needs and fits with the instructional goals of your school system. 55

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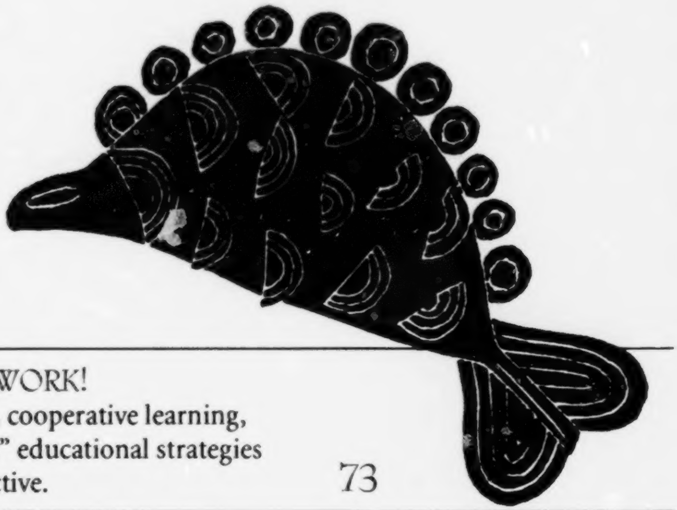

6 TEACHING STRATEGIES THAT WORK!
Focuses on lesson plans, learning styles, cooperative learning, discovery learning, and other "excellent" educational strategies that can make your program more effective. 73

7 ACTIVITIES, ACTIVITIES, AND MORE ACTIVITIES
From raps to role plays, this chapter looks at creating exciting and successful environmental education activities. It includes more than 50 sample EE activities that you can adapt. 95

8 MAKING AN ENVIRONMENTAL EDUCATION PROGRAM WORK
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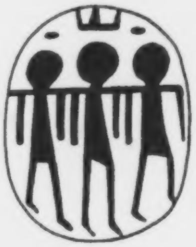
ENVIRONMENTAL EDUCATION IS WORKING IN BELIZE

In Punta Gorda, in southern Belize, a primary school teacher conducts a lesson on endangered wildlife and slash-and-burn agriculture. In the Cuyo District in the West, teachers are conducting lesson plans that look at air and water pollution. In Belize City, teachers are taking their students to visit the Belize Zoo and find out more about toucans, jaguars, tapirs, and other endangered Belizean wildlife. Throughout the country, teachers are integrating environmental education into daily lesson plans. Thanks to a joint project between Peace Corps Belize and the Ministry of Education, Peace Corps Volunteers are working with curriculum specialists, Belize Zoo educators, teachers, principals, and local environmental groups to help develop new materials and conduct environmental education workshops for teachers.

Since the project began several years ago, three new environmental education manuals have been produced for upper primary educators. These manuals focus on wildlife, land use, and pollution and include Belize-specific background information and teaching activities. Peace Corps Volunteers, working closely with District Education Officers and the Curriculum Development Unit, have also helped organize three series of environmental education workshops throughout the country, helping to train teachers to use the new manuals and develop innovative lesson plans that tie to the national curriculum.

Environmental activities have already made a difference in the way Belize "looks." Litter campaigns, carried out by students throughout the country, have cleaned up the streets and parks and given the country a "new look!"



INTRODUCTION

Never doubt that a small group of committed citizens can change the world; indeed, it's the only thing that ever has.
—Margaret Mead

In 1988 in a crowded conference room in Washington, D.C., a group of environmental education experts from around the world met with Peace Corps staff. The purpose of the meeting was to begin the exciting process of developing a strategy for incorporating environmental education into all Peace Corps training. Since then, environmental education has surfaced as a major initiative for all Peace Corps programming in the '90s.

Why the focus on environmental education? At present, more than 5.3 billion people are using (and often knowingly or unknowingly abusing) the earth's natural resources. In every corner of the world people are cutting forests, extracting minerals and energy supplies, eroding topsoil, polluting the air and water, creating hazardous waste, and disrupting natural areas at a rate unprecedented in the history of life on earth. As the pressures from overpopulation and development increase, it is becoming increasingly difficult for people to provide for their needs and wants. It is also becoming impossible to escape the consequence of severe environmental degradation: species extinction, spreading deserts, pesticide contamination, increasing public health problems, starvation, poverty, and loss of human life. Many experts fear that if the current rate of destruction continues, we will see the gradual breakdown of the very systems that support life on earth.

Sustainable Development

Development that uses natural resources in an efficient way and without destroying the basis of their productivity. Sustainable development allows natural resources to regenerate. For example, many indigenous people have practiced sustainable slash-and-burn agriculture in tropical forests for thousands of years.

Environmental education is a process aimed at improving the quality of life by empowering people with the tools they need to solve and prevent environmental problems. Environmental education can help people gain the knowledge, skills, motivation, values, and commitment they'll need to manage the earth's resources sustainably and to take responsibility for maintaining environmental quality.

The Peace Corps, in recognizing the importance of environmental education and the necessity of providing comprehensive training and support, has taken the initiative to sponsor sound and effective environmental education programming around the world. Through workshops, materials development, and collaborative efforts with other agencies and organizations in the U.S. and abroad, Peace Corps is working to make environmental education an integral part of all of its programs—from small business to agriculture to health to forestry.

Our goal in writing this manual is to help Peace Corps Volunteers (PCVs) and their counterparts working in schools develop strategies for creating effective environmental education programs. Whether you work with preschoolers or secondary students, rural or urban audiences, community-based education, or teacher training institutes, you can incorporate environmental education into your primary and secondary activities. And contrary to what many people think, environmental education is not tied solely to the science curriculum. It cuts across all subject areas, including business, economics, language arts, history, social studies, and the humanities. Although this manual focuses mainly on school-based environmental education, much of the information also applies to nonformal and community-based education programs.

Children are an important audience for environmental education because they are tomorrow's leaders and resource users. And in some cases children can influence parents and other community members. Volunteers and educators who work in or with schools and other educational institutions can have a tremendous impact, from increasing awareness and knowledge to helping form attitudes and facilitate action projects on behalf of the environment. It is also very important to recognize that women worldwide are the primary users of environmental resources, and that an effective environmental education program must be appropriate for female students and must have the support and buy-in from women in the community. And it's important to realize that there's no one right way to "do" environmental education.

As you can see from the table of contents, this manual focuses on a variety of topics relating to successful environmental education efforts, including teaching strategies, funding, evaluation, and activity development. But we don't tell you what to teach in this manual.

Instead, we hope to provide you with information and ideas to help you develop the programs that are most appropriate to your community and to your own situation, abilities, and interests. We encourage you to use this book as a starting point to help you structure a program that works best for you, and to adapt the activities and strategies suggested here to fit your needs. We'd also appreciate feedback from you. Please let us know how we can improve this manual and what successes (or setbacks) you've had in implementing environmental education programs.

We also encourage you to use two other manuals from the Peace Corps' Office of Information Collection and Exchange (ICE): "Conservation Education: A Planning Guide" and "Nonformal Education." The first is designed to assist PCVs and their counterparts in planning and implementing education programs that effectively address specific environmental problems. The latter is a creative and practical look at many aspects of nonformal education, including a guide to planning, evaluation, materials development, and adult learning.

Finally, we think it's important to mention the biases that we bring to this manual. We feel environmental problems are urgent and need to be addressed by the global community and that education needs to be an integral part of the solution. Conflicting opinions about the state of the environment, the consequences of environmental degradation, and the role of education make good subjects for discussion and debate. But we also feel that environmental education should not "brainwash" people into thinking a certain way: our hope is that it can help people learn how to think—including how to solve problems, make decisions, weigh options, and align values with personal actions.

As an educator, you possess the power to change lives and serve as role models for your colleagues and future Volunteers. We wish you much success and look forward to hearing from you.

Peace and survival of life on Earth as we know it are threatened by human activities that lack a commitment to humanitarian values. Destruction of nature and natural resources results from ignorance, greed, and lack of respect for the Earth's living things. . . . It is not difficult to forgive destruction in the past, which resulted from ignorance. Today, however, we have access to more information, and it is essential that we re-examine ethically what we have inherited, what we are responsible for, and what we will pass on to coming generations . . . Clearly this is a pivotal generation. . . . Our marvels of science and technology are matched if not outweighed by many current tragedies, including human starvation in some parts of the world, and extinction of other life forms. . . . We have the capability and responsibility. We must act before it is too late.

—Tenzin Gyatso
the fourteenth Dalai Lama

ENVIRONMENTAL EDUCATION IS HOT IN HONDURAS

In the late 1970s, Peace Corps Volunteers working as science teachers planted the "seeds of conservation" by teaching environmental education to teachers and conservation professionals at the National University and the National School of Forestry. Many of their former students now form the professional backbone of Honduras's environmental movement, both in the government and the private sector.

Today, Peace Corps Volunteers are continuing their environmental education activities by taking part in a variety of Ministry and NGO initiatives designed to improve environmental quality and manage resources sustainably. For example, Education and Environment Volunteers are working to institutionalize environmental education programs in 12 primary school Teacher Training Institutions. More than 6000 students graduate from these schools each year. In addition, Volunteers are helping to revise the natural science, social studies, and community development curricula and are helping to design a new environmental education curriculum.

Volunteers, working side-by-side with host country counterparts, have also helped organize a variety of training workshops and seminars at the national, regional, and local levels for host country officials, leaders, teachers, and NGO staff. They've also helped produce and distribute environmental education materials and visual aids, including the Manual de Educación Ambiental *produced by the Environmental Education Teachers' Group and the* Manual on Coral Reef Conservation *produced by the Bay Islands Conservation Association. In addition, Volunteers are using environmental education to educate children, teens and community members living in buffer zones of 20 priority protected areas.*

1

WHAT IS ENVIRONMENTAL EDUCATION?

One generation plants trees . . .
another gets the shade.
—Chinese Proverb

Volunteers in Fiji organize an adopt-a-beach program to help clean up litter. In Hungary, Volunteers teaching English prepare lesson plans focusing on air pollution. Students in Tanzania organize a tree-planting program to help reclaim the land. And in Ecuador, Volunteers work with counterparts to help students learn how to protect crops without using pesticides. All of these are examples of environmental education at work.

The goals of environmental education efforts around the world are similar—to maintain and improve environmental quality and to prevent future environmental problems. In part, environmental education is information education, increasing student knowledge about the environment. Students learn about global warming, solid waste, and other environmental problems; they learn about ecology and how the world "works"; they learn about the consequences of environmental degradation; and they learn about their role in creating and preventing environmental problems.

Environmental education also increases awareness about issues and an understanding of personal values by digging into attitudes and beliefs and helping students evaluate and clarify their feelings about the environment and how they contribute to environmental problems.

It helps individuals understand that there are conflicting values among people and that these conflicts must be addressed to ultimately prevent and solve environmental problems. Environmental education is also practical education: how to plant a tree, how to apply pesticides carefully, and how to plant crops to lessen environmental damage. And finally, environmental education stresses citizen action skills—from writing an effective letter to lobbying village councils, local and state governments, and national and international organizations.

> *I have a basic belief that what is wise is possible to do.*
>
> —Gro Harlem Brundtland

Environmental education has been evolving for many years. It got a big push in 1972, when representatives at the UN Conference on the Human Environment in Stockholm, Sweden recommended that the UN establish an international environmental education program. The United Nations Educational, Scientific, and Cultural Organization (UNESCO) followed up on the recommendation by sponsoring a series of environmental education workshops and conferences around the world. In 1975, representatives from member nations met in Belgrade, in the former Yugoslavia, to outline the basic definition and goals of environmental education. Then in 1977, representatives from more than 60 nations gathered in Tbilisi in the former Soviet Republic of Georgia for a follow-up to Belgrade. Delegates to these two international conferences ratified the following definition of environmental education, as well as a set of objectives (see below).

> Environmental education is *"a process aimed at developing a world population that is aware of, and concerned about, the total environment and its associated problems, and which has the knowledge, attitudes, skills, motivation, and commitment to work individually and collectively toward solutions of current problems and the prevention of new ones."*

Specifically, environmental education stresses these five objectives:

Awareness: Help students acquire an awareness and sensitivity to the total environment and its problems; develop the ability to perceive and discriminate among stimuli; process, refine, and extend these perceptions; and use this new ability in a variety of contexts.

Knowledge: Help students acquire a basic understanding of how the environment functions, how people interact with the environment, and how issues and problems dealing with the environment arise and how they can be resolved.

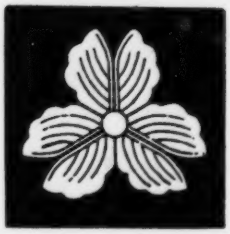
Attitudes: Help students acquire a set of values and feelings of concern for the environment and the motivation and commitment to participate in environmental maintenance and improvement.

Skills: Help students acquire the skills needed to identify and investigate environmental problems and to contribute to the resolution of these problems.

Participation: Help students acquire experience in using their acquired knowledge and skills in taking thoughtful, positive actions toward the resolution of environmental issues and problems.

The Tbilisi Declaration is a good starting point for thinking about what an ideal environmental education program should include. Since Tbilisi, environmental educators have been trying to take the recommendations one step farther by specifying what it is that makes a person environmentally literate. As in other disciplines, developing literacy criteria for environmental education has been a struggle. For example, what makes a person scientifically literate? How about culturally literate? And now, environmentally literate?

> *"Women have a vital role in environmental management and development. Their full participation is therefore essential to achieve sustainable development."*
>
> —Principle 21
> Rio Declaration



Environmental educators have been grappling with this last question for more than a decade. They've also been trying to determine how environmental education affects environmental literacy. Many environmental educators have thought about literacy in terms of what knowledge, skills, and behaviors a student should have when he or she leaves school. In general, literacy guidelines are based on the assumption that an environmentally literate person should possess:

- an awareness and sensitivity to the total environment
- a variety of experiences in and a basic understanding of environmental problems
- a set of environmental values and a feeling of concern for the environment, and the motivation and disposition to actively participate in environmental improvement and protection
- skills for identifying, investigating, and solving environmental problems

Although this is a good first step in helping educators understand what the ultimate goals of an environmental education program should be, there's still much debate about what environmental literacy is, how it should be defined, and whether it's possible to create a universal definition of literacy that holds true around the world.

What's in a Name?

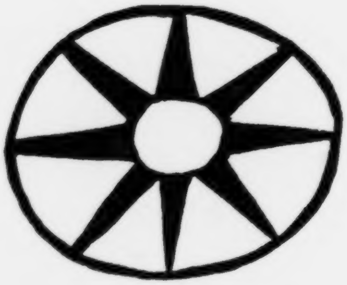
Some people are confused about the differences between *environmental education, outdoor education,* and *conservation education.* In this manual, we are using the term environmental education as a broad educational umbrella that focuses on the total environment (natural and built) and emphasizes attitudes, values, skills, knowledge, motivation, and participation to solve environmental problems. Conservation education is one component of environmental education. It focuses on education about natural resources and natural resource management issues. Outdoor education, such as survival education, camping, orienteering and other activities that take place outside the classroom focuses on self-development more than education about the environment. But it does encourage students to better understand the natural and built environments by taking part in a variety of outdoor learning experiences. Outdoor education can be an important part of both conservation education and the broader environmental education.

By learning you will teach; by teaching you will learn.
—Latin proverb

MORE ABOUT ENVIRONMENTAL EDUCATION

Before we get into the nitty-gritty of how to plan, implement, and evaluate an environmental education program, here's a brief overview of some of the issues associated with environmental education, what the research says, and what we'll be focusing on in the following chapters of this manual:

"THINK GLOBALLY, ACT LOCALLY"



First coined by author and historian Rene Dubois, this phrase is a catchy way to remind students that environmental problems are often global in scope, but are most effectively tackled at the individual or community level. Students may feel helpless about global ozone depletion. But they can feel empowered when they learn that by not using certain types of plastic foam, they can help reduce ozone-depleting chemicals. This phrase also reinforces how critical it is for students to examine their own behaviors and to understand how individual actions affect global issues. Although it's important for students to understand the international, national, and regional nature of environmental problems, often the most effective environmental education programs help students look at how their own actions at a local level can cause and help prevent or solve environmental problems.

MORE THAN SCIENCE

Many educators link environmental education exclusively with science education. Although a large chunk of environmental education does deal with an understanding of science concepts, it also requires an understanding of economics, math, geography, ethics, politics, and other subjects. In the next several chapters, we'll look at the interdisciplinary nature of environmental education and strategies for integrating environmental education throughout the curriculum.

YOU DON'T NEED TO BE AN EXPERT

Don't think you need to be a scientist or environmental education professional to incorporate environmental education into your teaching. As we've said earlier, environmental education is much more than one "subject"; it involves values education, decision making, communication skills, creativity, and many other subjects and skills. As an educator, your role is to facilitate learning and to know how and when to get the experts involved if they're needed. By incorporating environmental content into your teaching, you can try new activities and approaches and learn more about environmental issues along with your students.

MAKING THE FIT

Environmental education can take many forms. In some school systems, environmental education is carefully integrated throughout the curriculum, relying on a guiding scope and sequence (i.e., planned integration by grade and subject) that ensures that objectives are met throughout a student's schooling. In other school systems, the approach is more piecemeal, with bits of environmental education popping up in different classes and different grades, but without the cohesive structure of a scope and sequence (see Chapter 5 for more about scope and sequence). A few schools offer year-long or semester-long courses that deal specifically with some aspect of the environment, including environmental issues, environmental problems, resource management, and so on. And some schools integrate environmental education throughout the curriculum and also offer environmental courses in middle and high school. But many school systems do not have a school-wide environmental education program at all and instead rely on motivated individuals to incorporate environmental education into their teaching. Finally, many schools do their environmental education after school—in clubs and weekend community activities. In Chapters 2 and 3, we'll look more closely at strategies for incorporating environmental education into a school or classroom curriculum and how to develop a program that is right for you. And in Chapter 9, we'll look at how to evaluate your programs to determine how effective and efficient they are and how to use evaluation to improve your program.

> *The First Law of Environmental Education: An Experience is worth 10,000 pictures.*
>
> —Noel McInnis

Discovery Learning!

In classrooms around the world, teachers lecture, students take notes, and then students are tested on what they've learned. However, in many classrooms experiential or "hands-on" learning is starting to replace or supplement traditional "chalk-talks." Through experiments, simulations, debate, and other participatory activities, students discover concepts on their own. Experiential learning has been shown to increase retention, motivate students to learn, and encourage group cooperation. It has been especially successful with environmental problem-solving activities. In Chapters 6 and 7 we'll look at a variety of hands-on environmental education activities and techniques that can be adapted for use in schools around the world, including ideas for enhancing lecture-style teaching.

Get Outside!

Many people argue that students around the world—especially in urban areas—are losing touch with the natural world. In many places, outdoor experiences are not a regular part of instruction; instead of occurring throughout a student's schooling, outdoor experiences are often limited to a few outings in primary grades. Getting students out into the environment on a regular basis is an important part of a comprehensive environmental education program. Nothing can replace first-hand experiences to help students understand their community, natural systems, and environmental issues.

Using the environment as a classroom is also a way to bring your students closer to nature. For example, many language educators take their students outside for reading and to stimulate creative writing. And many science and math educators use the environment as a laboratory in which students conduct investigations and experiments.

THE BUILT, THE TECHNOLOGICAL, AND THE NATURAL

What is the connection between the "built" environment and the natural environment? The number of people moving to and living in urban areas is increasing at an unprecedented pace in many parts of the world. How does urban living affect people's attitudes about the surrounding environment? How is technology controlling natural and human environments? What are the ethical questions surrounding the use of new technologies? How is a quality environment maintained in an expanding urban environment? These are some of the questions that environmental education strives to answer. In Chapter 7, we've included several sample activities that focus on urban issues. The Bibliography also lists resources that can help you incorporate urban activities into your teaching.

GET "REAL"

Getting students into the community to look at the natural and built environment can make environmental education programs more relevant to the lives of students. As you focus on real systems, problems, and solutions, your students get first hand experiences that are often missing in educational programs. These "real" experiences not only enrich the curriculum, but can also help strengthen the ties between your educational program and the community.

> ***We shape our buildings and afterwards our buildings shape our world.***
>
> —Winston Churchill

It's also important to be sensitive to the realities of the environmental problems facing your community. Many of your students and their families may be directly or indirectly responsible for the environmental problems that your students investigate. For example, if you work in Central Europe, many of your students' parents will probably work in the factories that are polluting the air and water. And in Africa, some of your students and their families or relatives might be contributing to the poaching problem. Although you shouldn't shy away from discussing environmental problems because of this, you do need to be sensitive to "laying blame" and think about the best way to present certain issues. (See Chapter 6 for more about teaching controversial issues in the classroom.)

KNOW YOUR AUDIENCE

There's a good chance that what is educationally appropriate in Cincinnati, Ohio won't be appropriate in Banjul, The Gambia or Nuku-Alofa, Tonga. Educators understand the importance of being sensitive to cultural diversity when creating an effective education program. Understanding how people perceive their environment and how they view themselves and their place in the environment is also very important to the success of a program. It's also important that you realize how your ideas about the environment and education might differ from those of the people you will be working with. By better understanding your audience, you can make your teaching more meaningful and relevant to their lives and more culturally appropriate.

In the next two chapters, we'll look at ways to assess your community, your environment, your school system, and your students, and how to use this assessment to develop a more effective, culturally appropriate environmental education program.

THINK! THINK! THINK!

One of the goals of an environmental education program is to help students develop the ability to think—both critically and creatively. A student who might someday become part of a local governing council will be most effective if he or she can successfully weigh options, identify alternatives, communicate, ask the right questions, analyze input, and make decisions. The same holds true for a student who might someday be a landowner trying to decide how to manage his or her land or a citizen asked to take sides on an issue that affects the environment and the community. In Chapter 5, we'll look at how to incorporate thinking skills into an environmental education program. We also encourage you to read more about the topic by checking out the resources listed in the Bibliography.

> *Tell a child what to think and you make him a slave to knowledge. Teach a child how to think and you make all knowledge his slave.*
>
> —Henry J. Tait

VALUES COUNT

Environmental education is inextricably linked to values. As children mature, the value system they develop influences the choices and decisions they make regarding all aspects of their lives, including environmental issues. Values also add consistency to a person's life, which helps to build a better self-concept. In Chapter 4, we'll look more closely at the connection between values, beliefs, and attitudes and the development of an environmental ethic. (Also see Chapter 7 for several examples of activities that focus on values clarification and value analysis strategies.)

EMPOWER!

An environmental education program can do much to help empower students to improve the quality of their lives and the lives of others. And this empowerment can lead to increased feelings of pride and self respect. When students take part in a community project to help improve environmental quality or solve a community problem, they are helping themselves and helping others at the same time. They are also affirming their values and seeing that their actions can make a difference.

TOUCH THE KIDS, TOUCH THE PARENTS

Although many of you will be working primarily in schools, you can also have a lasting impact on your students' parents. In some cases, parents may be educated by their students. This "parent education" takes place when students bring home new information and skills, and it often provides the impetus to discuss and debate issues, ideas, and feelings. You can also have an impact on parents in the community through activities that bring students, parents, educators, and others together to achieve a common goal.

TAKE ON A SECONDARY PROJECT

There's a natural link between formal and nonformal environmental education efforts. For example, many teachers provide the spark to get wildlife and environmental clubs off the ground and to encourage students to take part in community programs designed to solve a problem. Many Peace Corps Volunteers working in schools are also taking part in secondary projects related to the environment—and they're tying environmental education to other activities and subject matter as well. For example, in Hungary, a group of English teachers has organized a summer camp emphasizing English language skills, environmental awareness, and action.

ECO-ECONOMICS

What is the connection between economic stability and environmentally sustainable development? How can people make enough money to survive and still protect the environment so that resources will not be depleted? Is it possible to use resources sustainably, even in countries where food, shelter, and clean water are in short supply? Educating students about the relationship between a healthy environment and a healthy economy is a critical part of environmental education—and a part that's often been neglected in the past. In Chapter 7 we've included several activities that can help students understand what the word "sustainable" means and how it applies to development and the environment. We've also included a variety of resources in the Bibliography that focus on environmentally sustainable projects and that help clarify the link between economic issues and the environment.

> *In our every deliberation, we must consider the impact of our decisions on the next seven generations.*
>
> —Iroquois Confederation,
> 18th Century attributed

MOVING TOWARD ENVIRONMENTALLY RESPONSIBLE BEHAVIOR

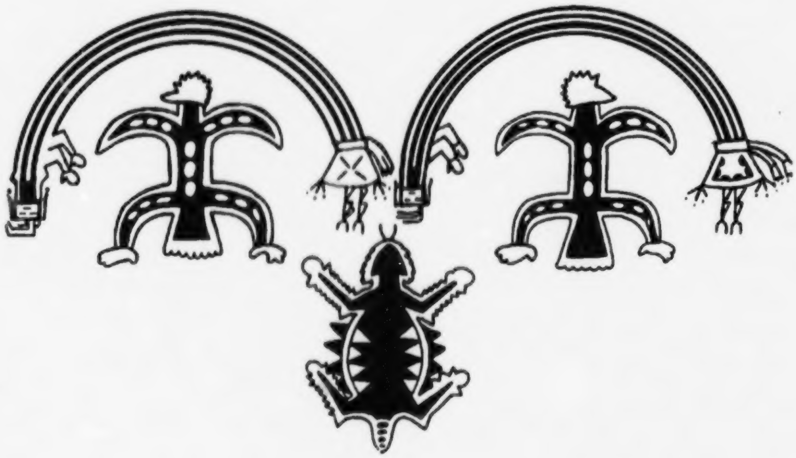
In the past, many environmental education efforts have focused mainly on awareness. These programs often included activities that helped students get in touch with the natural world and become aware of environmental problems. This was especially the case with many of the environmental education programs developed in the 1970s, which relied heavily on sensory activities and outdoor experiences to help students relate to the natural world. Although awareness is a critical part of environmental education, most educators would agree that without incorporating the five objectives listed on pages 6-7 into a cohesive program, your efforts will not be as likely to achieve tangible results.

There is also an increasing impetus to move students beyond awareness to environmentally responsible behavior. Many environmental educators feel that the road to environmentally responsible behavior is a continuum that begins with environmental awareness and knowledge and ends with students becoming actively dedicated to improving and maintaining environmental quality.

LIGHT A SPARK!

As an educator, you can have a lifelong impact on your students by incorporating environmental education strategies into your teaching. Environmental quality is directly relevant to the lives of your students and their families. By helping them know what their rights are as citizens, empowering them to take action and feel they can make a difference, clarifying the connections between individual or family health and the environment, showing how personal finance and the environment are linked, and getting them excited about the natural world, you can spark a personal ownership in environmental concerns. And don't worry that you can't do everything—lighting a spark is a good start.

> *The mind is not a vessel to be filled, but a fire to be ignited.*
>
> —Plutarch



HUNGARIAN TEACHERS MAKE A DIFFERENCE!

Like most countries in Central and Eastern Europe, Hungary suffers from a host of severe environmental problems, including acid rain, smog, water pollution, hazardous waste disposal problems, and loss of habitat. Although the problems can be overwhelming, Peace Corps Volunteers have made a commitment to begin tackling the environmental issues and are working with schools, non-governmental organizations, and local community groups. For example, Volunteers who are teaching English as a foreign language (TEFL Volunteers) in secondary schools and universities are incorporating environmental content into their lesson plans. Their students are learning English by taking part in debates, exhibits, poetry contests, and other activities that focus on air and water pollution, solid waste, and natural resource issues. These Volunteers are also working with their counterparts to sponsor English/Environment camps during the summer, where students of all ages improve their English skills and take part in a variety of environmental education activities

One TEFL Volunteer, Kevin Anderson, who was working as a secondary school teacher, got involved in a secondary project to help protect one of Hungary's most pristine rivers—the Tisza. Working with the Nyireghyaza Chapter of the Hungarian Ornithological and Nature Protection Society, Kevin worked with a colleague to get a $10,000 grant from the Regional Environment Center to survey the upper river and riverside forests, educate the public about the ecology of the river, and disseminate information. Since getting the grant, the river has been surveyed and mapped, an educational video about the importance of the river has been produced, and the city of Nyireghaza has decided to become part of the Green City program.

2

PLANNING FOR SUCCESS

Before you buy shoes, measure your feet.

—West African Proverb

Sara arrived in Tonga determined to help solve environmental problems through education. She was assigned to a secondary school on one of the smaller islands in the Tonga group. Sara knew she would be teaching biology and math to secondary students, and with her interest in global climate change and other environmental problems, she hoped she could incorporate information about the global environment into her lesson plans—while at the same time making her lessons relevant to her students. For example, she knew that some scientists feel global climate change is harming coral reef communities around the world—something that would directly affect the people of Tonga. She thought that if she could get them hooked, some of her students might actually want to pursue an environmental career.

What Sara soon found was that most of her students were at a different "place" than she had imagined. Most had never left the village where they were born, and none of them had much concept of the rest of the world. Her supervisor told her that most of these students would probably never leave the island, and that the majority would end up fishing, farming, or selling crafts for a living. Furthermore, Sara found that she was expected to teach from a very structured syllabus that was extremely academic and theoretical, with objectives that didn't seem relevant to her students' future prospects. Her supervisor expected her to prepare her students for the final exam, which was based on a formal New Zealand curriculum. After looking at student records, she found that most never passed the exam. Sara also found that her school had no laboratory and limited supplies for conducting biology demonstrations and experiments. And she found it was extremely difficult to teach in a crowded classroom where students had never been encouraged to ask questions. On top of all that, many of her students didn't understand English very well.

Given the realities of her situation, Sara wondered if she should scrap her interest in environmental education and just help her students pass the tests. Maybe it wasn't important for her students to know about the problems associated with global warming and ozone depletion, even though both could have devastating effects on them in the future. If her students were going to fish for a living, maybe understanding global climate change just wasn't a priority.

Like Sara, many educators around the world are faced with decisions about what to teach and how to teach it. They're also trying to deal with large class sizes, different cultural backgrounds, lack of materials, apathy, and unrealistic curricula and tests. Next to all of these problems, environmental education often takes a backseat.

In Sara's case she felt environmental education was important, but she wasn't sure just what type of environmental education program would be best for her students. And when faced with some overwhelming teaching constraints, she became more confused about how to decide what to teach.

In the next few chapters we're going to look at some of these problems. What type of program is best for your situation? What should your environmental education priorities be? What concepts are most important? And how do you effectively size up your situation to know what's best?

It's important to understand that there's no one right program. In some cases, you might have the resources, support, and interest to design a cohesive, integrated program that tackles the most pressing problems and also looks at long range goals. In other cases, the approach might be more piecemeal or more targeted to solving a specific problem. But no matter what your situation is, you can incorporate environmental education with the goal of helping your students improve the quality of their lives and the lives of those around them.

In the following section, we'll look at a planning process that you and the teachers you work with can use to help determine what the content of your environmental education program should be. If you're well-versed in environmental education, resource management, or general science, some of this will be a review. But you might find that working through this process will be a helpful and necessary step in developing an effective environmental education program that fits the needs of your students and is culturally appropriate. In some cases, you might find that you have to adapt much of what you learned about applying environmental education in your own country. And if you're just getting your feet wet in environmental education, we suggest that you read through the planning process, keeping in mind that you can simplify and adapt it to meet your particular needs. (No matter what you teach, we feel you should go through some type of planning process so that you can measure your effectiveness.)

As you assess your environment, we also strongly encourage you to work with other educators—especially if you don't feel comfortable with environmental education. For example, if you're a Peace Corps Volunteer teaching English, you might want to work with environmental education Volunteers, in-country experts, experienced teachers, and others to help you develop a program that you can use to help teach content-based English through a whole language approach. We also want to remind you that upcoming chapters provide more nitty-gritty information about how to fit an environmental education program into your situation and how to develop activities and strategies.

> *Always get your counterpart and colleagues involved when you want to develop a new program, course, or activity. They know a lot more than you do and can provide needed support and insight.*
>
> —A Volunteer from Paraguay

WHERE DO YOU START?

Assessing your community is the first step in developing an effective education program of any type—especially an environmental education program. Even if you plan to start small, it's important that your efforts meet the needs of your students, school, and community. Here are some of the factors to consider when you develop your strategy:

- The environmental problems that exist in the community and in the country (from both your perspective and from that of the people who live there)
- The characteristics of the school system, including the strengths and weaknesses of the curriculum, the skills and enthusiasm of the teachers, techniques used by host country educators, and the interests and agendas of the community and school administration
- The students' and parents' expectations about what "good education" is
- The resources available, including money, textbooks and other teaching materials, information about the environment, and so on
- The age, knowledge, skills, and attitudes of the students and how the students are likely to contribute to solving environmental problems
- The cultural/social norms of the country

- the political realities of the community, school system, and country
- the economic situation in the community, including the potential for future employment of the students

In this chapter, we'll look at how to size up the environmental conditions. In Chapters 3 and 4, we'll look at how to assess your school and students.

WHAT MAKES THE COMMUNITY "TICK"?

Before you assess the environment in your community, it is important to understand the community itself. One of the most effective ways to better understand a community is to talk to people who live there. It's important that you know what the people in your community feel are their most pressing concerns and what the beliefs, superstitions, and taboos are. You should also become familiar with important customs that separate community residents from "outsiders." And it's useful to understand how residents react to new ideas, how information is communicated, how decisions are made, and who the community elders are. If you are a Peace Corps Volunteer, your "official" counterpart, as well as neighbors, friends, and fellow co-workers, can help you better understand the community's characteristics. It's also important to have a clear understanding of the roles and responsibilities of men and women in your community.

> *"You never really understand a person until you consider things from his point of view. . . . Until you climb into his skin and walk around in it."*
>
> —Harper Lee

Answering the questions starting on page 31 and completing an initial survey will help you plan a more effective education program. But don't feel that you have to spend months researching and preparing a plan of action. Learn as much as you can initially, and then continue to learn and adjust as you go.

However, it is important to carefully define what you hope to accomplish so that you use your teaching time and resources wisely. In many cases, a "less is more" philosophy is what makes the most sense because you won't be able to do everything. Unfortunately, determining what to leave out is often the most difficult part of teaching—especially when you have so many demands pulling on you at the same time.

To help keep your efforts on track, we suggest that you use the planning process we outline below, adapted from the book *Course Design* by Posner and Rudnitsky (1978), which is described in "Conservation Education: A Planning Guide (M-23)" published by Peace Corps' Information and Collection Exchange (ICE).

Note: If you don't feel that you have time to go through a formalized planning process, you might want to skip to Chapters 6 and 7 to pick up some methods and strategies for incorporating environmental education into your teaching immediately. However, we feel it is always important to do some preliminary planning so that your program is not a collection of haphazard activities that don't achieve your objectives.

WHAT ARE THE PROBLEMS?

To design a relevant environmental education program, it's important to know what the local, regional, and national environmental problems are in your country. You might already have a good idea of what the problems are, but it's still necessary to check out your thoughts through observations, interviews with specialists and community members, and research. Resource specialists, community leaders, university teachers, researchers, and international environmental groups, such as the World Wildlife Fund, can all help you sort out what the problems are and how serious they are. And if you are in a community where women are the predominant heads of households—talk to them. They can provide you with information about the environment that is normally unwritten. (To find out more about how to assess the environmental situation in your area, see "Conservation Education: A Planning Guide" [ICE M-23]. For sources of information about environmental issues, see the Bibliography.)

It might help to make a list of all the environmental problems that you discover and group the problems according to type. For example, you could divide the problems into waste issues and into those involving the over-use of resources. You might also want to indicate which problems are most pressing in your local area and whether the problems affect a larger region of the country as a whole. If you are working in Eastern Europe, your list might look like this:

WASTE ISSUES

AIR POLLUTION
- smog
- ozone depletion
- acid rain

WATER POLLUTION
- hazardous waste
- sewage problems
- heavy metals
- agricultural run-off
- leaking landfills
- polluted water coming into the country from other countries

SOLID WASTE
- landfills/dumps
- incinerators/air pollution
- plastic/litter
- hazardous waste storage

RESOURCE ISSUES

FORESTS
- over-harvesting
- cutting trees to make pasture and grazing lands

SOIL
- erosion
- irrigation/desertification
- contamination
- over-mining

WILDLIFE
- hunting/trapping
- loss of habitat
- loss of species

WATER
- drought
- overuse

ENERGY
- overuse of coal, oil, and gas
- type of energy resources available

Other countries would probably have a list of similar problems, no doubt with some additions and deletions. For example, a list for Gabon might include coral reef destruction and poaching, as well as many of the other problems listed here. However, it probably would not include smog, ozone depletion, and other industrial environmental problems.

WHAT ARE THE CAUSES AND CONSEQUENCES OF THE PROBLEM AND WHAT ARE THE SOLUTIONS?

As you assess the environmental problems, it's also important to think about, and list, what or who is causing the problems, what the consequences are (ecological, health, social, and economic), how the problems can be solved, and what is preventing these solutions from being implemented. In some cases, an environmental problem has many causes, and it's important to get to the root of the problem to figure out the best solution. For example, if deforestation is a problem, who's cutting the trees and why? Is it farmers who are clearing the trees to plant crops? Is it timber companies selling the hardwoods for a profit? Or is it a government policy that's encouraging cattle pasture? Maybe it's a combination of many causes.

> *We see an increasing number of so-called environmental refugees, particularly in Africa—hundreds of thousands of people trying to escape from an environment that can no longer sustain them.*
>
> —Prince Aga Khan

Again, there are many people and resources in the community who can help you assess the problems, their root causes, their effects on people and the environment, and their solutions. University professors; experts in the Ministry of Environment, Agriculture, or Health; your Associate Peace Corps Director (APCD) for natural resources or environment; the resources in the Peace Corps library or ICE; and experts working in conservation organizations in your community will be able to supply information about local and regional environmental problems. And the solutions will vary, depending on the severity of the problem and the resources available. For example, does the government (local or even national) need to set aside nature reserves or pass new environmental legislation or establish fuelwood plantations? Can the local people take action themselves—for example, can they use better soil conservation techniques to prevent the washing away of tons of topsoil every year? Do people need training to solve the problems they're facing, such as a course to help them learn how to apply pesticides sparingly and safely?

HOW CAN YOUR STUDENTS HELP SOLVE THE PROBLEMS—BOTH NOW AND IN THE FUTURE?

In thinking about local environmental problems, make sure to consider the role your students play in causing a problem and the role they could play in helping to solve the problem. For example, are they part of the problem now? How are their families connected to the problems? How well do your students understand the problems and from what perspective? Are they motivated to help find solutions? Have some students taken part in efforts to find solutions?

It's also important to think about the future role your students will play in the community. Will they be farmers or fishers, industrial workers or white-collar workers, religious leaders or politicians? Will they live in the capital city, in villages, or on small farms—or will they be nomads? Will they hunt, gather firewood, vote in local and national elections, and so on? How will they relate to the environmental problems confronting the country and community, and how will they be able to help solve the problems?

You should also consider how students can help solve environmental problems now. Can they plant trees, design educational exhibits for the community, write to their government representatives, or help others learn how to plow on the contour? (Depending on your background and experience, you might need to ask experts or colleagues about the types of solutions that make the most sense for your students and community.)

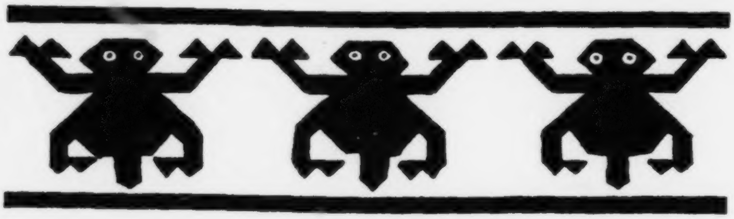
WHAT IS THE ROLE OF EDUCATION IN HELPING TO SOLVE THE PROBLEMS?

Now you can start thinking about what type of environmental education program is most appropriate and how education can best address the problems in your community and country. Do members of the community need an understanding of ecological concepts or information about what's causing the problem? Are there specific critical thinking skills such as problem-solving or decision-making that can help them understand and tackle the problems? Are there practical skills that can help them solve the problems immediately, such as learning how to plant a tree or plow on the contour? Are they motivated to get involved? Do they agree that what you see as a problem is a problem? If not, why?

WHO CAN HELP?

> *Don't ever be afraid to ask for help!*
> —RPCV from Nepal

As you size up the environmental situation and think about your educational objectives, it's also critical to get buy-in from the beginning and to identify people who can help you with your community and school assessment and with your efforts to develop an effective environmental education program. Although you will probably be working in schools or teacher training institutions as a primary assignment, you may find that making contacts in the community will help you achieve your goals more effectively. For example, local non-governmental organizations involved in environmental issues may be willing to work with you and your school officials to develop a comprehensive environmental education curriculum, provide speakers for classes, conduct field trips to environmental "hot spots" and natural areas, or help support you in your efforts to work with government officials. You might also find that working with farmers, town leaders, and the general public can help your students get actively involved.



PLANNING WHAT YOU WANT TO ACHIEVE

Plans are the dreams of the wise.

—German Proverb

The following four steps—writing a problem statement, writing a rationale, writing the program's goals, and writing the objectives—can help you and your colleagues plan a successful environmental education strategy for your situation. You can use this planning process if you are a teacher, a school administrator, a teacher trainer, a community youth organizer, or any other professional working with students.

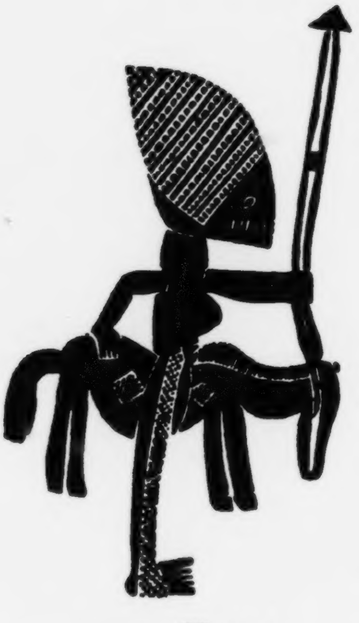
1. WRITE A PROBLEM STATEMENT DESCRIBING THE ENVIRONMENTAL PROBLEMS YOU WANT TO ADDRESS.

For example, if you live in a community where you see many environmental problems occurring regularly, your problem statement might look like this:

EXAMPLE A. *People in the community seem to lack an understanding of how their actions affect the environment and consequently, affect their own lives. Many people use pesticides regularly, kill wildlife frequently, clear forests in a manner that causes soil erosion and depletes future supplies of forest resources, and toss litter in streets and yards regularly.*

If you are working in a coastal community and see a variety of problems that directly impact the ecological health of the area, your problem statement might look like this:

EXAMPLE B. *People living in a coastal community are harming the coral reefs and mangrove swamps that supply most of the resources the people depend on to survive. Specifically, they are overharvesting fish and sea turtles, overcollecting sea-turtle eggs, dumping human waste into the bay, constructing houses and industry so close to the bay that sediment is running into the shallow coastal waters and smothering the coral reefs, anchoring boats on the coral and permanently damaging coral communities, breaking off huge hunks of coral to sell to tourists, and cutting mangrove trees, which provide critical habitat for many sea creatures.*



2. WRITE A RATIONALE EXPLAINING WHY THIS PROBLEM DESERVES THE ATTENTION OF A SCHOOL ENVIRONMENTAL EDUCATION PROGRAM.

By writing a rationale, you can help ensure that your education program is focusing on the most significant environmental issues affecting your community or country. It will also help the educational program attract the resources and support it needs to be effective.

Here are rationales for the two examples given in step 1:

EXAMPLE A. *It's important for people in the community to understand how their actions affect the environment and the quality of life for all the people that depend on the resources. It's also critical that all citizens learn how they can do things differently to reduce the environmental damage and ensure that* *there will be a continual supply of natural resources in* the *future. A school environmental education program can help prepare tomorrow's adults to be aware of environmental problems, understand how to use resources sustainably, and learn how people's actions contribute to the problems and can solve the problems.*

EXAMPLE B. *Unless people know how they are damaging marine resources and what they can do differently to reduce the damage, they run the risk of permanently destroying the resources they depend on to survive. A school environmental education program can provide information about the problems and consequences, show how harvesting marine resources sustainably makes economic and environmental sense, help students understand how they feel about the problems and what role they have in solving the problems, and provide opportunities to help educate others in the community about the problems.*

3. STATE THE PROGRAM'S GOALS.

The rationale explains why the environmental education program is needed; the goals describe what you hope to accomplish. The goals should be specific enough to define what you want the students to learn from your program.

Here are goals for the two examples we've been discussing:

EXAMPLE A.

- To understand the ecology of the region or country.
- To understand how people's actions affect the environment.
- To understand how personal feelings and attitudes affect actions.

EXAMPLE B.

- To understand ecological relationships in the marine community and how people depend on marine resources to survive.
- To understand how people's actions affect the coral reef and mangrove swamp and what people can do to protect these resources.

4. WRITE THE PROGRAM'S OBJECTIVES

In this stage, you should outline specifically what you want students to learn from your environmental education program. The objectives, developed from these learner outcomes, should be measurable, focused, and student-centered, developed from the outcomes you have identified. For example, one objective might be that students will be able to write letters to a government official about the coral reef problem. Another might be that students will be able to state several ways ecological relationships in the coral reef are threatened by human activity.

You'll probably discover that as you plan your environmental education strategy, it is difficult to narrow down the specific objectives you want to achieve. It's also easy to get sidetracked, which can hinder your efforts to reach the goals you outlined earlier. Continually checking back to the goals you want to achieve is important. But it's also critical to understand your school, your community, and your students before completing your objectives (see Chapter 3). Since you don't have unlimited time and resources, the more appropriate your program is, the more effective it will be. For example, if you work in a rural community where the student drop-out rate is very high and more than 90% of the students will become farmers, your intended learning outcomes might be very specific: students might learn, for example, that farmers should plow on the contour, plant windbreaks, leave jaguars alone, and apply pesticides safely. On the other hand, if you work in an urban area, where many of the students will finish school and go on to work in government, universities, and other white-collar jobs, your objectives might be much broader, with more emphasis on learning about the country's natural resources, environmental problems, ecological processes, and so on.

Note: In this manual, we are recommending that your objectives focus on the performance or behavior you hope to achieve through education. According to many educators, an objective should also have two additional components: the conditions under which the behavior will take place and the criteria used to evaluate how well the behavior was performed. Using the example above, a three-part objective might read:

Given information about coral reef problems and a field trip to a coral reef, write a letter to a government official that outlines three problems affecting the coral reef and how the problems can be solved.

When developing objectives, it's also important to think about what types of prerequisites (knowledge, skills, attitudes) are needed to achieve your goals. For example, if one of your objectives is to have students analyze fishing regulations, it's important that they first understand reef ecology, economic realities of the community, and other related topics. Prerequisites are important as you try to decide what to teach at what grade level. (See Chapter 5 for more about curriculum planning.)

You might also want to start developing your objectives by listing the types of behavior/actions that you, your colleagues, and experts in the community feel would improve environmental quality. Although this preliminary list can help direct your teaching, it's still important for your students to investigate a variety of solutions and alternatives to an issue, taking cultural norms, economic realities, and other factors into consideration. It's also important for you to listen to what local experts say. Although you might have strong feelings about what needs to happen in your community, others, including students, parents, and Ministry officials, might not agree with your assessment. And you might find that you do not understand the consequences (on the culture or community) of one decision over another as well as citizens that have lived in the community their entire lives. The goal of your education program should not be to dictate new behaviors to your students, but to help them learn how to investigate the pros and cons of environmental and economic decisions that are made in the community so that they can become effective and involved decision-makers in the future.

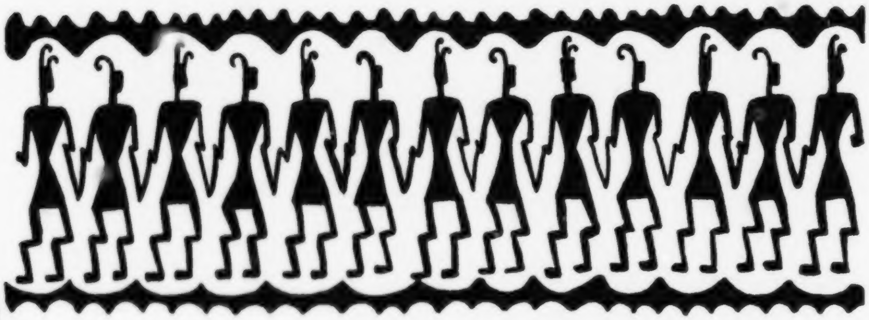
For example, here's a sample showing possible actions that local experts feel would help lessen the problems affecting the coral reef (example B):

- Stop walking on coral and damaging it with anchors.
- Support and follow regulations limiting the seasons, catch sizes, and harvesting techniques for reef fishes, spiny lobsters, sea turtle eggs, and corals.
- Stop cutting mangroves.
- Plant fuelwood in a community woodlot to use instead of mangroves and help care for the seedlings.
- Support efforts to inform government leaders about the need to finance a waste water treatment plant.
- Implement soil conservation measures on local farms to reduce sediment washing into the bay and help protect the coral reefs.

> *Harmony with land is like harmony with a friend; you cannot cherish his right hand and chop off his left. . . The land is one organism.*
>
> —Aldo Leopold

Your environmental education program should help the students understand the problems and the consequences of current behaviors and alternative behaviors. And, through activities and experiential learning, help them to see the difference that new actions could take. For example, older students could investigate one or more of these recommended actions to find out why people are not currently taking them, what the consequences (economic, social, etc.) might be of implementing one or more of these new behaviors, and what cultural or economic barriers might currently prevent people from changing their behavior.

After listing potential solutions (gathered from local experts) and reviewing your goals, the next step is to develop objectives for your program. The sample objectives on page 26 are designed to address some of the coral reef problems in this example. They are listed under the five major components of environmental education: awareness, knowledge, skills, attitudes, and participation. (When developing objectives, it's also important to consider higher level thinking skills, moral development, and other learning goals. See Chapter 5 for more about curriculum development.) This list will give you an idea of the types of objectives you might want to build into your program.



AWARENESS AND KNOWLEDGE

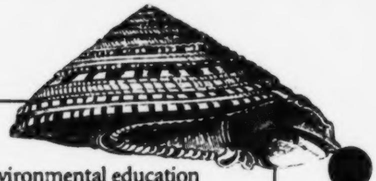
After completing this environmental education program, students will be able to:

- List five threats to marine resources in their community and country (overfishing, destruction of coral reef, destruction of mangrove habitat, and so on).
- Describe the consequences of mangrove habitat destruction.
- List the advantages and disadvantages of taking the following actions to solve the coral reef problems: establish and enforce fishing regulations, use soil conservation measures, construct primary and secondary sewage treatment plants, establish tree plantations to provide alternative sources of fuelwood, establish sea turtle nesting beach reserves.
- Draw a diagram of life histories of important marine fish and explain how to identify these fish (habitat, food habits, breeding behavior, seasonal movements, and so on).
- Draw a diagram of life histories of coral (reproductive behavior, habitat requirements, how sedimentation harms coral, importance of coral reef to marine creatures, and so on).
- Outline the life histories of sea turtles and how to identify adults and young.
- Explain why the reef is economically important.
- Describe how changing water quality affects the reef.
- Define the concept of sustainable yield, with regard to fish and turtles.
- Draw a diagram of ecological relationships in the bay (marine food chains: sun—phytoplankton—zooplankton—larger creatures; symbiotic relationships; habitat requirements)
- Develop a plan on how to guard sea-turtle nesting beaches and sea turtle eggs.
- Give examples of environmental action projects designed to protect coral reefs that were successful and unsuccessful.

PARTICIPATION

After completing this environmental education program, students will be able to:

- Demonstrate and implement simple soil conservation techniques to prevent sedimentation.
- Organize and implement a beach clean-up.
- Design and carry out an education program for fishers.
- Plan and implement a program to demonstrate snorkeling techniques for tourists and community members that don't damage the ecology of the reef.



SKILLS

After completing this environmental education program, students will be able to:

- Predict how threats to marine resources will affect them personally and affect their families and community (fewer fish, fewer tourists and less money in the community, and so on).
- Compare and contrast alternative methods for protecting the coral reef.
- Design an education program targeted at local fishers about dangers to the coral reef.
- Work in small groups to design a "safe" way to anchor boats.
- Graph the changes in water quality over the past 10 years.
- Visit the coral reef without damaging it.
- Analyze a case study involving an environmental problem by defining the problem, identifying key players, describing the underlying attitudes and beliefs that affect the problem, and discussing alternative solutions.
- Fish in ways that don't damage the ecology of the reef.
- Evaluate the effectiveness of a coral reef educational program for primary school students.
- Write a persuasive letter to convince a family member to change a behavior that is harming the reef.
- Design an experiment to test the advantages and disadvantages of a new method to harvest a threatened marine species.

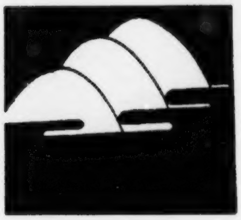
(Note: These represent different types and levels of skills, including creative thinking skills, critical thinking skills, and practical "hands-on" skills. For more about skill development and classification, see Chapter 6.)

ATTITUDES

After completing this environmental education program, students will be able to:

- Explain what would need to happen for people to change their behavior about overharvesting, walking on the coral, and anchoring their boats.
- Describe how people's attitudes about coral reefs vary.
- Describe how they feel about the possible extinction of sea turtles and why.
- Describe and justify their own attitudes about coral reef problems and their commitment to protecting coral reef resources.
- Write how they feel about a new law that would limit harvests and protect the coral reef, but would cause their family to lose money.
- Discuss why individual behaviors do not always correspond to what individuals feel they should be doing to protect coral reefs.

The objectives for Example A, which focused on urban issues, might be broader and less clearly defined than those presented here for Exhibit B. For example, objectives for an urban school program where most of the students will end up with white collar jobs or move to another city or country and pursue advanced degrees might include looking at the country's natural resources as a whole, the relationship between economic security and sustainable environmental processes, how laws and regulations are passed in the community and country, and how citizens can have input in the political process. (See the Appendix for sample curriculum frameworks that take a broad view of environmental education.)



SUMMARY

Through this initial planning process, you should begin to develop a clear idea of what you hope to accomplish in your environmental education program. You should also be working closely with your colleagues as you plan, set goals, and develop objectives. By outlining environmental goals and objectives, you will be ready to move to the next steps of site assessment and program development. These questions are a reminder of the planning you need to do before developing a school environmental education program:

QUESTIONS TO THINK ABOUT . . .

1. *What environmental problems are confronting the community? Confronting the country?*
2. *Which problems are most significant to the country and community? Which are most significant to the students you will be working with?*
3. *How will the students you will be working with be most likely to help solve these problems, both as students and later as adults?*
4. *What information and skills do the students need to have so they will be able and motivated to help solve the environmental problems? (The program's objectives)*

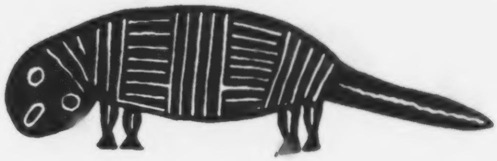
THE FOUR LAWS OF ECOLOGY . . .

1. *Everything is connected to everything else.*
2. *Everything must go somewhere.*
3. *Nature knows best.*
4. *There is no such thing as a free lunch.*

—Barry Commoner, 1971

A WEST AFRICAN ENVIRONMENTAL EDUCATION INITIATIVE

Desertification, habitat destruction, salt water intrusion, and a variety of other environmental problems plague communities in The Gambia and Senegal. To help tackle these problems, Peace Corps Volunteers are actively involved in a variety of formal and nonformal environmental education activities. Several Volunteers in The Gambia have been working on a special project to help educate Gambian students about endangered chimpanzees and other wildlife and habitat issues. Working with renown primate scientist Janice Carter, these Volunteers conduct environmental education programs for students who visit the chimp reserve to help them learn more about endangered wildlife and other issues that face West Africa. Volunteers also work in nature reserves and parks, where they conduct environmental education programs, design exhibits, and visit schools to talk about environment issues. And many Volunteers, working on forestry and agriculture programs, are implementing community environmental education programs to help students and adults understand local issues and come up with community-based solutions.



3

MAKING ENVIRONMENTAL EDUCATION FIT!

The most important task, if we are to save the earth, is to educate.

—Peter Scott

Maurice was starting his second year of teaching in a school in southern Poland. Although he had experience teaching language arts and social studies at home, he was now teaching English as a foreign language in a mid-size Polish town. His first year had been tough, especially since he was trying to get used to the country, his fellow teachers, and the curriculum, while at the same time trying to learn Polish and develop strategies for teaching a second language.

He had also been overwhelmed by the environmental problems in the country. The water was so polluted that everyone boiled it, and those that could afford to, filtered it or drank bottled water. The air pollution was choking at times, and he knew there were problems with hazardous waste sites, radiation, and landfills. The conditions in the country seemed so overwhelming, he didn't even know where to start. And although his students knew the situation wasn't good, they seemed apathetic about getting involved or thinking they could tackle any of the problems. At first, he thought he could help best by introducing environmental topics into his teaching every now and then. But as time went on, he found that he was struggling with just getting through the lessons and helping his students with basic English. And he didn't feel he was having much impact with his haphazard attempts to incorporate topics into his grammar and vocabulary lessons.

Change is always powerful.
Let your hook be always cast.
In the pool where you least expect
it, will be a fish.

—Ovid
(43 B.C.-A.D. 17)

During a holiday break Maurice was talking with several of the Polish science teachers at his school about his dilemma. His colleagues suggested that they try to start an after school ecology club to get students interested in environmental issues and help solve simple community problems such as organizing a stream clean-up or picking up litter. Together, they worked out some ideas, involved several students in the planning process, and started the club meetings. Although it took a while to catch on, more students joined. Maurice and his colleagues let the students run the club, giving advice and feedback when needed. And although the club members never did tackle litter in the community, they did organize a community petition to encourage community leaders to build a large landfill to replace the three large open dumps that were currently being used. They also sponsored a clean-up of a dump on the bank of the local river and wrote and performed a play for younger students. Throughout the summer, many of Maurice's students joined the club. And he found that with more students taking part in club activities, environmental discussions became more animated in his English classes. Although Maurice still knew that the environmental problems in the community would take many years to solve, he felt that he and his colleagues were facilitating student leadership and motivating students to take an active role in improving the environmental quality in their neighborhood.

As we mentioned in Chapter 1, there's no one way to "do" environmental education. As Maurice found, the best route for him was to incorporate environmental education into a secondary project instead of focusing on changing the curriculum. Had Maurice been working with a curriculum development unit or working with science or government teachers, he might have made a different decision.

In the previous chapter, we looked at how to assess the environmental problems in your community and country, which is the first step in starting a school environmental education program. The next step is to assess your school. In this chapter, we'll look at how to assess the educational situation and see how environmental education can best fit into your activities and programs.

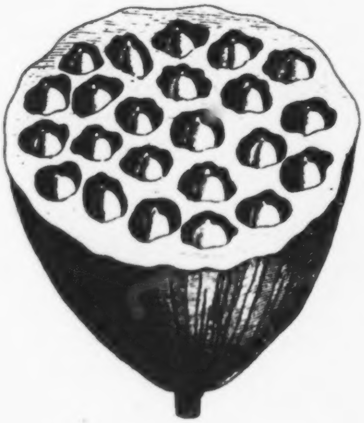
SIZING UP YOUR SCHOOL SYSTEM

Before trying to decide what type of environmental education program is most appropriate for your situation, you need to understand your school system and how education in general "works" in your community. For example, how are decisions made about instruction? What is the quality of pre-service and in-service teacher training? What types of resources are available? Answering questions like these can help you create a more effective environmental education program that meets the needs of the students, your colleagues, and the administration. It can also help ensure that your program is implemented by the school and that you have the support of your colleagues and administrators.

To help you size up your situation, try answering the following questions about the school, teachers, students, instruction, and curriculum. Many of these questions are generic and will help you develop any type of education program. Others are related specifically to an environmental education program. To help answer these questions, try to get input from other teachers, administrators, students, and members of the community. You can use the answers to help you develop your program. For example, if there is no money for field trips or materials, you might be able to look at creative fund-raising activities, or if teacher training is lacking, you might want to build workshops into your program. And don't worry about trying to answer all of these questions. Just use this survey as a guide to help you better understand your school.

Children are our most valuable resource.

—Herbert Hoover



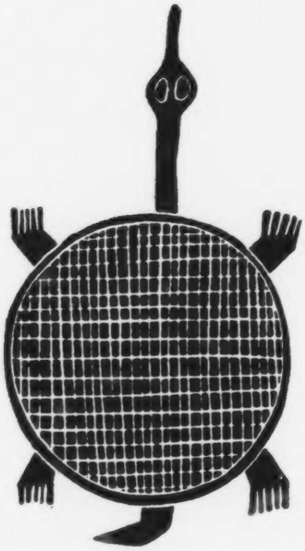
GET TO KNOW YOUR SCHOOL

STUDENTS

- How many students are in the school?
- What are the ages of the students that attend the school? What are the ages of the students you will be working with?
- Are students ranked? If so, how? Are students of varying abilities grouped together? To what degree?
- Are special education students grouped with other students?
- What types of extracurricular activities do the students engage in after school and on weekends?
- How motivated are they?
- What are their long-term ambitions and goals?
- What is the ratio of boys to girls?
- What is the drop-out rate for the school? What are the reasons given for the drop-out rate? Do more girls drop out than boys? Why?

TEACHERS

- How many teachers are in the school?
- What is the student/teacher ratio?
- What type of instruction is preferred by the teachers? For example, is lecture the most common teaching method?
- What opportunities exist for teachers' professional growth? (e.g. in-service workshops, conferences, advanced courses)
- Are there local and national professional groups for a particular area of study? For example, a science teachers' group? A math teachers' group?
- Do teachers communicate effectively? Are there regular staff meetings?
- Are teachers motivated? Are there a lot of complaints about the school system? The students? The pay?
- Are teachers overworked? Is the workload reasonable?
- What factors might be affecting morale? (e.g., resources, education, low status in the community)
- What are the minimum requirements needed to receive a teacher's certificate?



TRAINING

- What type of pre-service training do teachers receive? Are there teacher training colleges? What type of instruction is used?
- What type of in-service training opportunities exist? Who oversees and coordinates in-service training? What is the quality of training?
- Are new programs implemented with accompanying training programs?
- What have been the most successful training efforts in the school? Why?

SCHOOL ADMINISTRATION

- Who makes the decisions in the school system? The principal? Department heads?
- Is the atmosphere rigid or flexible? Friendly and relaxed or stressful?
- Do teachers have input into decisions?
- Is there much collaboration between departments?
- Do school officials have contact with the Ministry of Education? If so, what interaction is there?

CURRICULUM

- Is there a national curriculum? Do individual schools and school districts have input into the curriculum? Do teachers have input into revisions?

- Is environmental education currently a part of the curriculum? If so, where is it currently taught or infused?
- Do teachers feel that the curriculum is workable and relevant?
- How often is the curriculum revised?
- Are there textbooks? Do they match the curriculum?

TESTING AND EVALUATION

- Is there a national test? If so, when do students take it? Is there more than one?
- What is the pass rate on standardized tests?
- What type of yearly assessment is done? Who does the assessment?
- Is informal assessment part of a student's final grade?
- How strict is grading?
- Do final tests include questions related to environmental education, including questions testing knowledge, thinking skills, citizen action, and so on?

RESOURCES AND SPECIAL FEATURES

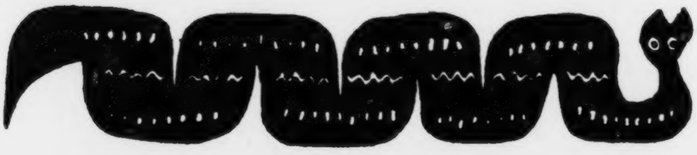
- Is the school environment conducive to learning? Are there posters and displays on the walls? Are the classrooms protected from the elements? Is there enough light?
- Are the classrooms an appropriate size? Are there enough desks and chairs?
- Are there enough supplies? Chalkboards and chalk, books, paper, chemicals, and so on?
- Is there a nature study area or garden on the school grounds or nearby? Are natural areas within walking distance? Within driving distance?
- Is money available for field trips?
- Are there plumbing and electricity?
- Are photocopying or other duplicating services available? Is audiovisual equipment available?

COMMUNITY THOUGHTS ABOUT EDUCATION

- Does the community value education? Are teachers respected? Do parents support their children's efforts?
- Does local business support educational efforts with money, speakers, or resources?
- Is there any type of community input into school system policies?
- Are there any community education programs?
- How do religious or cultural attitudes affect the educational system?
- What, if any, are the obstacles to girls receiving an education?

ADDITIONAL LEARNING OPPORTUNITIES

- Are there opportunities for students to get advanced degrees?
- Are there extension education courses or adult training programs in the community?
- Are there community library programs?



PICK THE FIT

Once you have a feel for your school system, it's easier to make decisions about how an environmental education program should be implemented. As mentioned in Chapter 1, there are two primary ways to incorporate environmental education into your teaching, with much variation and overlap between the two. Here's a brief overview of both:

THE INFUSION METHOD: This method incorporates environmental education content and process into established courses throughout the curricula. Traditionally, environmental education has been infused mainly into science, history, and social studies classes. But it can be infused into all subject matters, including reading, writing, languages, math, music, physical education, art, and other courses.

> *The time is always right to do what is right.*
>
> —Martin Luther King, Jr.

THE BLOCK METHOD: This involves adding specific classes or units focusing on environmental science, environmental issues, environmental action, and other environmental topics to the curriculum. For example, in middle school, students might take an environmental science course that teaches biological, earth, and physical sciences with an environmental perspective. Then in high school, these students might take a current events class focusing specifically on environmental issues and problem solving. Or there might be one or two units in a social studies class dealing specifically with environmental issues.

Because there are advantages and disadvantages to each method, we recommend that a school system use both methods, when possible. Here's a quick look at the pros and cons of each method:

THE INFUSION METHOD—ENVIRONMENTAL EDUCATION THROUGHOUT CURRICULUM

PROS

- fewer resources are needed (don't need an EE specialist or a separate textbook, etc.)
- doesn't compete with other standard subjects; doesn't compete for a slot in the curriculum
- can be done immediately, without core curriculum development
- many supplementary resources exist
- encourages transfer of learning and integrated problem-solving across the curriculum
- appropriate for all age levels, although may be more difficult at upper grades
- allows all students at all levels an opportunity to get exposure
- when done on a large scale, can continually reinforce and build upon key environmental concepts

CONS

- is difficult to infuse EE and requires extensive teacher training and effort
- often relies on motivated teachers for efforts to succeed
- EE message can be so diluted to fit the objectives of a course that it can get lost/students might not "get it"
- leaves too much to chance
- difficult to evaluate success

THE BLOCK METHOD—CREATING SEPARATE ENVIRONMENTAL EDUCATION COURSES

PROS

- easier to implement as a single subject
- allows teacher to present concepts that build throughout the course
- teacher training is somewhat easier, although it requires teachers to have a more in-depth background
- easier to evaluate as a separate course
- pulls everything together for students and can achieve greater depth and comprehension
- puts a priority on the subject

CONS

- hard to get schools to "buy" it
- needs trained EE teachers (requires more in-depth knowledge)
- takes time from other standard topics (hard to squeeze in with other curriculum demands)
- might imply that the environment is its own subject and not interdisciplinary
- hard to find qualified teachers to design and teach courses
- not as easy to see the connections with other subjects
- may limit the number of students exposed
- may cause some teachers to assume environmental education "is not my responsibility"

In addition to free standing courses related to the environment and infusion, there are some additional ways that educators are incorporating environmental education into the curriculum, including:

Development of Modules: Instead of trying to fight for year-long environmental issues classes, many educators are trying to push for an environmental unit or module that can be added to a social studies or civics class or to a science class.

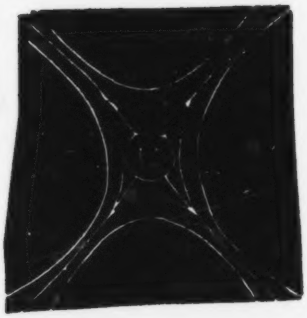
After School Clubs: Many schools try to bring interested students together after school to form environmental clubs, focusing on environmental issues, nature, and community service. These clubs and activities might be linked to already established groups.

Environment Week or Month: From Earth Day to Environment Day to Earth Action Month, there are many ways that schools around the world try to focus attention on the environment by celebrating special environmental events. In some cases, traditional classes disband for a day or more, and special environmental education activities take place at the school or in the community. Special multi-disciplinary environmental education materials often enhance the effectiveness of these activities. (Many schools hold special events on June 5, which is World Environment Day, and April 22, which is Earth Day.)

Nonformal Activities: Many educators in the schools also work with educators in the community to blend formal and nonformal environmental education efforts. For example, many teachers take their students to zoos and museums for environmental education activities, and conduct pre- and post-activity lessons. Many Volunteers are also focusing secondary projects on environmental education activities, sponsoring environmental education camps, community clean-ups, and other activities.

Tips and Tricks for Incorporating EE Into the Curriculum

After sizing up your school and talking to colleagues, you'll have a better idea of what makes the most sense for your individual situation. If you are working with the curriculum development unit in a country, you might have an opportunity to work with your colleagues to infuse EE, develop free-standing courses, or create a curriculum that blends both methods. If you are teaching specific classes at specific grade levels, you might only have the flexibility to infuse environmental education into what you're already teaching.



Although we strongly recommend that schools offer year-long classes focusing on environmental issues at the middle school and secondary school level (in addition to infusing environmental education throughout the curriculum), we know that in many school systems this isn't possible. Instead, many of you will need to focus your environmental education efforts on infusing concepts into existing curricula. The trick with infusing environmental education is to figure out how to get the environmental concepts that you feel are important to coincide with the objectives of established courses. You need to match the list of concepts developed in your environmental assessment (Chapter 2) with the course goals and objectives of your school and grade level. Each objective you have developed needs to be paired with the class and grade level where it can best be taught. In this way, you can ensure that key concepts do not fall through the cracks as your program becomes implemented. (See page 60 for more about infusion.)

In some cases, your objectives will fall naturally into one class. However, in most cases, you will find that your environmental education objectives need to be incorporated into several classes at different grade levels. For example, if you have several objectives related to the causes and solutions of tropical deforestation, you would probably want to infuse some of the objectives into several classes covering all ages. Elementary students might focus on rain forest plant and animal life, products people get from a rain forest, and where rain forests are located in their country. In older grades, students in social studies class might look at why a rain forest is important to a country's economy and how different people view the problems. And in upper level science classes, students could explore the ecology of the rain forest in more detail, conduct experiments with soil erosion, and learn about nutrient recycling.

The list below shows some of the subjects in which environmental education can be easily infused into existing subjects.

SCIENCE: Environmental concepts fit naturally into general science, biological science, physical science, and earth science. Sample topics include sunlight, energy flow, photosynthesis, food chains, food webs, nutrient cycling, predator/prey relationships, pollination and seed dispersal, symbiosis, and other ecological concepts; plant and animal life cycles, habitats, and other natural history information; how natural systems are affected by people (killing predators, spraying pesticides, and so on), chemistry of water and air pollution; alternative energy sources; hazardous waste disposal; earth's place in the universe, history of life on earth; soil formation and erosion, non-renewable and renewable resources; and so on.

HEALTH/NUTRITION: Environment and health are closely linked in a variety of ways. Of course, environmental degradation (smog, radiation, contaminated food and water, and so on) directly harms human health. But many other health and nutrition issues tie directly to the environment: risk assessment, indoor air pollution and smoking, effects of water and air pollution, lead and other heavy metal contamination, pesticides and safe food, over-grazing and cattle production, and so on.

HISTORY, ECONOMICS, AND SOCIAL STUDIES: A large chunk of environmental education deals with history, economics, and social studies. Sample topics include how the environment has shaped human civilization and different cultures and how humans have impacted the environment through history (e.g. how soil erosion, loss of trees, water

WORKING WITH A NATIONAL CURRICULUM

In most countries of the world, teachers are required to adhere to a national curriculum. Although the curriculum varies from country to country, it is usually developed by the Curriculum Development Unit in the Ministry of Education and is sometimes adapted from another country's curriculum. For example, the curriculum used in Tonga and Western Samoa was adapted from New Zealand's national curriculum. The Gambia is using a modified British curriculum. And the Comoros is using an adapted French curriculum. In many countries, the curriculum can be very rigid, and it can cover too many topics, forcing teachers to cover a large amount of material in a very short amount of time. In addition, the curriculum is often a list of points to be covered, without materials or activity ideas to help teachers teach the content. And in some cases, the material is not always relevant to the students and does not make allowances for special learners.

The challenge these teachers and administrators face is finding ways to incorporate innovative teaching strategies and locally relevant content and skills that can enhance required objectives. Infusing environmental education into a national curriculum is a way to achieve both goals. By including environmental content into all subject areas, you can increase the use of hands-on learning, group cooperation, and other progressive teaching strategies. You can also help students understand local, relevant issues and develop the skills they will need to address them. And in those countries that don't supply activity ideas and materials to supplement the curriculum, you can work with your colleagues to help develop creative environmental education materials that can help achieve Ministry objectives.

It's also important to remember that change takes time. Making small inroads in daily teaching and teacher training can bring about larger changes in the curriculum in the future.

He who listens,understands.

—West African Proverb

pollution, species extinction, and so on have influenced history); the importance of natural resources to a nation's and community's economy and stability; how a country's political process works and how citizens can get involved in issues concerning the environment and health; how past leaders have dealt with environmental issues; the role of women in community action projects and natural resource use; and so on.

LANGUAGE ARTS/TEFL/READING/CREATIVE WRITING: In many countries around the world, Volunteers are teaching English as a foreign language. There are many opportunities to blend English lesson plans with environmental education content. For example, writing poetry about nature, pollution, environmental ethics, and other topics can help improve writing skills and allow students to focus on attitudes and feelings about environmental topics. Students can also practice writing letters to community leaders about environmental concerns, read articles about environmental topics, learn new vocabulary related to the environment, compare the works of nature writers or public policy makers, improve thinking and speaking skills by debating environmental topics, and so on. In cases where English teachers are developing lessons and materials without an existing curriculum, or where the syllabus specifies only grammatical structures, they can develop or select topics related to the environment and then base vocabulary and grammar lessons on them.

MUSIC, DANCE, DRAMA, AND ART: In many cultures, people communicate most effectively through the arts. By combining environmental education concepts into these subject areas, students can often gain more than if the material was presented through textbooks, lectures, or other more traditional teaching styles. There are many opportunities to combine environmental education with the arts, or when teaching these subject areas. Students can write and perform songs, chants, and plays or they can create dance movements to accompany essays or poetry, draw or paint pictures focusing on environmental topics, create displays showing how a community has changed over time, and so on. In addition to learning new information and gaining insights, students can improve dexterity and psychomotor skills.

MATH: Math and environmental education make a natural fit. Math can become more relevant and effective when it's taught within an environmental context. There are many ways to blend the two subjects, from conducting simple calculations to figuring out more complicated word problems and analyzing data. In primary grades, students can use math to create community maps, sample animal and plant populations, figure out averages and percentages related to environmental questionnaires and surveys, graph data, and so on. As they get older, math can help them understand more complicated data focused on environmental field studies, risk assessment, and other issues linking science, technology, and the environment.

HOME ECONOMICS: In home economics classes around the world, young people are learning how to become responsible consumers and decision makers. Much of what they learn will have environmental consequences, from deciding what type of detergent to buy to how to get rid of insect pests. You can also tie food issues to health and nutrition, resource issues, and energy. For example, understanding the resources needed to get different types of food to the table can help students make choices about which foods to buy. (See Chapter 7 for activities dealing with food and resource issues.)

PHYSICAL EDUCATION: Environmental education and physical education are linked in several ways. For instance, many outdoor activities that teach ecological concepts also have a physical component, including running, climbing, hiking, and so on. Outdoor activities, including hiking, canoeing, backpacking, camping, orienteering, and fishing can also play a role in environmental education, as can issues concerning outdoor ethics, hunting, and fishing.

SUMMARY

As an environmental educator, you will have to adapt your message to fit the realities of the schools in which you work. From class size to Ministry objectives, there are many things to consider as you develop your program. Since environmental education programs work in many different ways, they can be adapted to fit many different kinds of schools.

One thing to keep in mind as you develop your environmental education goals is that it's not just important for your students to acquire knowledge, skills, and attitudes. It's also important for them to be able to transfer what they learn to real-life situations and problems. To do that, they need to experience a diversity of problems and to learn to apply the principles they learn in a variety of situations. In the next chapter, we'll look at how students develop intellectually and morally to help determine how to match your objectives to the level of your students.

> *The world is a beautiful book, but of little use to [people] who cannot read it.*
>
> —Carlo Goldoni

QUESTIONS TO THINK ABOUT . . .

1. *Have you surveyed the students, teachers, administrators, parents, and community members to find out about the educational system in your community?*

2. *How can EE best be incorporated into the subjects you teach?*

ACTING UP IN THAILAND

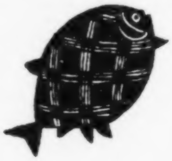
In 1991, thirty-one shy young women from Mareerat Girls High School in Phrae province in northern Thailand, two pioneering teachers, a government community development worker, and Peace Corps Volunteer Cindy Robinson joined together to form a drama club, the Phrae Youth Environmental Theatre Project. None of them had ever been on stage before. Now, just one year after its initiation, the theatre troupe, which calls itself "Saeng Tien," or "Light of the Candle," has helped spread the message of environmental conservation to thousands of students across Thailand.

Robinson got the idea for the theatre project after reading about another theatre group in a refugee camp in northeastern Thailand. "I like the idea of using drama as a means of communication, "she explained. "And this type of project does not require any special technical or educational skills on the part of the PCV or the participants. Anyone of any age can be involved."

The Saeng Tien Club hopes to promote and enhance environmental awareness in Thailand, especially with children in the community. Cindy and her co-workers also wanted to promote leadership skills, creativity, and critical thinking skills for young women and to encourage them to take an active role in environmental policy in the future.

Saeng Tien performs acts that focus on deforestation, wildlife protection, air and water pollution, and anti-littering. "We want the shows to be educational, but also entertaining," says Ms. Needanat Thinchom, one of the teacher advisors for the group. "We believe an interactive approach is the best way to accomplish our goal."

On April 22, they celebrated Earth Day with a special performance in Bangkok. And they have plans to continue their environmental work, including the production of a video that will be available on loan to help spread the conservation message throughout Thailand. (Adapted with permission from The Exchange, Winter, 1993.)



4

GETTING TO KNOW YOUR STUDENTS

No two things are exactly alike.

—West African Proverb

Robin's assignment was in the Curriculum Development Unit (CDU) on a small island-country in Asia. The Ministry of Education wanted to revise the current curriculum and infuse environmental education into the new curriculum design.

With his biology degree and teaching experience at a university, Robin felt confident in his ability to incorporate appropriate content into the curriculum. He noticed that the existing primary curriculum already included topics such as energy, ecology, and animal life cycles, and he began to build on these topics to develop his lesson plans and incorporate more environmental content.

After working for several weeks to revise a primary curriculum unit, he showed his work to one of his colleagues in the CDU. Although his friend told him the content was good, he explained that the level was much too high for these primary students. Some of the activities called for high level critical thinking skills, as well as a thorough understanding of ecological principles. It also assumed that the teachers would be able to handle open-ended discussions and understand the ecological content. He also said that the activities that dealt with values were much too complicated and controversial for most of the teachers to facilitate.

For the next several weeks, Robin visited classrooms throughout the country to get a better idea of student levels and teaching methods. He also read information in the CDU about how to match teaching objectives to the developmental level and background of students. When he started revising the curriculum again, he asked for input from teachers and his colleagues at the CDU to make sure that the concepts and methods were appropriate for the level of the students.

It's easy to make the mistake Robin did when he first started incorporating environmental education into an existing curriculum. If you don't fully understand the level of the students or what is appropriate for their culture or background, the activities you create may be inappropriate or have unrealistic objectives.

No matter what you're teaching, it's important to know your students. If you're an experienced teacher, you will already have a natural feel for what works and what doesn't with the students you have been teaching. You will also have a feel for how your students develop intellectually and morally as they mature. As a newcomer in another country, however, you will probably need time to develop a similar feel about your new students. And you will need to understand how factors such as nutrition, prior education, home environment, and cultural traits can affect students' intellectual and moral development. If you're new to teaching or are working with an unfamiliar age group, it can also help to review theory about how children develop.

I like teachers who disturb the inertia and schools that are colorful with diversity among the teachers. Inevitably, that also allows for color and diversity of expression among students.

—Sara Lawrence Lightfoot

After assessing the environmental situation in your community and sizing up the school system, you'll have a better idea of what type of environmental education program makes the most sense. But as you think about what type of program is most appropriate, it's also important to:

- match your goals and objectives to the students' developmental level
- make sure the content is relevant to the students' needs, interests, and backgrounds
- build on what the students are learning in other classes
- include a component that deals with the development of an environmental ethic
- integrate thinking skills that tie directly to the type of behavior you hope to promote

In this chapter, we'll briefly review how students develop intellectually and morally, with a close-up look at values education and how students can develop an environmental ethic. We'll also look at how to tie theory and assessments together to design an effective program that makes the most sense for your situation.

FROM PIAGET TO BLOOM: HOW KIDS DEVELOP INTELLECTUALLY

No matter how the lesson is presented, a six-year old student will not be able to analyze the pros and cons of nuclear energy or write a persuasive essay in favor of sustainable development. Determining what is appropriate for children is an important part of planning effective lesson plans and activities. Jean Piaget, a Swiss psychologist, was instrumental in helping educators understand that students go through different stages of intellectual development and that at certain times in their lives they are better able to understand abstract concepts, moral reasoning, and so on. Although the stages of development do occur in somewhat predictable patterns, they vary with each individual, depending on experience, economic background, ethnic background, and previous learning. Here's a brief overview of Piaget's research and what it means for environmental educators. (Note: Piaget's research focused on white, middle-class European boys. Many educators feel that his research is transferable to girls and to other economic and cultural groups, but others say more research is needed to verify this.)

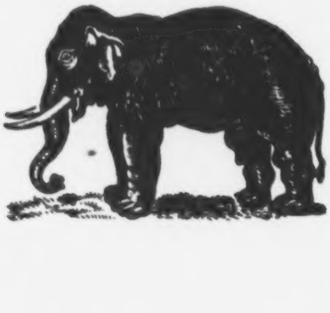
Children enter school as question marks and leave as periods.

—Neil Postman

THE YOUNG ONES: Children that are 18 months to 7-8 years have not yet developed the thought processes to reason or think logically. But they do start to use language to communicate, use very unsophisticated processes of trial and error to accomplish things, and have the ability to establish mental "pictures." At this stage, students can draw things they have experienced, use an object to represent another object (a stick can symbolize an animal, for example), and imitate something from memory.

What's appropriate: This is not the time to introduce complicated issues or activities. Students will have a difficult time following step-by-step procedures, looking at a variety of variables, understanding relationships, absorbing a lot of information, and making judgements. What does make sense is to focus on environmental awareness activities that rely on the senses, helping students focus on their feelings about the environment, introducing limited content, and providing positive outdoor experiences for children. It's also important to start introducing students to appropriate environmental behavior.

THE BEGINNING OF LOGIC: From ages 7-8 to 11-12, students start to use logic to solve simple problems, group and classify items, and understand how lengths, weights, and other measures compare and relate. At this level, students begin to make judgements based on reason, can understand a reverse act or procedure (if 2 + 3 = 5, then 5 - 3 = 2), and can begin to classify objects and understand that groups of objects have more than one property (such as color, weight, and size). Overall, students still think primarily in black-and-white and rely on facts to solve problems.



What's appropriate: At this stage, students are ready for more information about their environment and can handle activities that deal with classifying, comparing, organizing, and explaining what they observe. It's a good time to focus on knowledge and attitudes, but students should continue to take part in awareness activities, especially those dealing with environmental problems. Although most students have not yet reached the level of abstract thinking, they can begin to work on higher-level thinking skill development, such as investigating cause and effect, identifying the players and problems in an environmental issues scenario, and brainstorming possible consequences of environmental problems. However, they are unable to deal with complex moral issues.

AN ABSTRACT THOUGHT From ages 11-12 to 14-15, students begin to think in abstract terms and really start to hypothesize and use deductive reasoning. This is the level at which adult thought processes really begin, and with appropriate instruction, the student can analyze events and understand probability, correlations, combinations, proportional reasoning, and other higher-level thinking skills.

What's appropriate: Most students begin to think at a higher level before the age of 11 or so, but it doesn't really become the favored way of thinking until students reach this age. At this stage, students can begin to speculate on unknown alternatives or what might be. Most students go beyond black-and-white analysis (things/people are all one way or another) and think about complex behaviors. Many students also become idealists and imagine what could be rather than sticking to reality and the status quo. Although students should continue to gain knowledge about environmental issues, it's important to help students focus on critical and creative thinking skills, attitude development, and understanding their roles in causing and solving environmental problems. Students at this age are also actively deciding for themselves what is "right" and "wrong." Role plays, simulations, case studies, questionnaires, creative writing, debates, and other activities can help develop students' expanding intellectual levels.

The job of a citizen is to keep his [or her] mouth open.

—Günter Grass

HIGHER THINKING From ages 14-15 and up, students can design experiments, come up with hypotheses involving different variables, and exhibit many higher-level thinking activities.

What's appropriate: Students should continue to work on critical and creative thinking skills, including problem solving, analysis, persuasive writing, and other higher-level skills. It's also important for students to better define their roles as responsible citizens and begin to refine personal ethics. Students should be encouraged to attend and sponsor meetings, conduct research, write reports, analyze media, and so on.

CLASSIFY YOUR LEARNING

One way you can think about what to teach is to think about what "domain" the learning is taking place in and at what level in that domain. Learning takes places in three main domains: cognitive (the "knowledge" domain), affective (the "attitudes and feelings" domain), and psychomotor (the "physical or motor skills" domain).

Benjamin Bloom, a well-known educational theorist, suggests that there is a hierarchy of levels in each domain, with each new level building on the previous one and representing a higher intellectual, emotional, or physical stage. According to his theory, often known as "Bloom's Taxonomy," a student needs practice in the lower stages of learning to really understand the higher stages. For example, in the cognitive domain, Bloom and his fellow researchers identified these six major levels:

- KNOWLEDGE: recalling facts, ideas, and information
- COMPREHENSION: grasping the meaning of material
- APPLICATION: using rules, principles, ideas, and methods learned previously in a particular situation
- ANALYSIS: breaking something down into parts and distinguishing relationships and organizational structure
- SYNTHESIS: combining pieces, parts, and elements into a new "whole"
- EVALUATION: making quantitative or qualitative judgements about the value of material for a given purpose

> *Too often we give children answers to remember rather than problems to solve.*
>
> —Roger Lewin

When planning program and lesson objectives, Bloom would say it's important to include objectives dealing with each of the six levels, when developmentally appropriate, starting with the lower levels and moving up. For example, if one of your learning outcomes in Central and Eastern Europe is to have students be able to evaluate conflicting evidence about the causes and consequences of acid rain, you might develop a program that starts out with knowledge activities and moves to evaluation activities. And depending on your situation and the level of your students, this process might take place during a three-week unit or over a longer period of time, at different grade levels in the curriculum.

For example, students might begin with lessons about weather and the water cycle, then move on to what acid rain is, what causes it, and where it occurs. Next, students could gather data and analyze it. And they could answer questions, such as "Is the situation serious? If so, what is causing the acid rain and what can the students do about it?" If you don't have access to data collection equipment, you can use a detailed case study involving acid rain to analyze what the problem is, who the players are, and what the underlying causes of the problem seem to be. Students could write an essay about some aspect of the case study or local situation and could evaluate each other's arguments. In this example, you have moved from knowledge to evaluation, and along the way the students have had a chance to practice a variety of higher-level thinking skills.

Although this building block approach is extremely helpful in understanding different thought processes, many educators feel that it's important not to structure a program strictly on taxonomy or a six-step process. Many students at younger grades can handle some higher level thinking skills, as long as the skills are represented with appropriate content and tasks. Conversely, some older students might need more reinforcement of basic skills. And every teacher can't teach everything in every lesson plan or program.

If you are designing a course, we recommend that you keep this hierarchy in mind as you develop your objectives. If you are part of a curriculum committee looking at skill development, we recommend that you identify the most important thinking skills and integrate them throughout primary and secondary levels, increasing the difficulty of the content, instruction, and tasks as students get older. For example, using Bloom's taxonomy as a guide, your program could emphasize the skills of comparing and contrasting in primary grades, using different levels of complexity in each grade. But you might decide to focus on skills involving synthesis in upper elementary and secondary grades. (See the Appendix for more about thinking skills and Bloom's Taxonomy.)

ETHICS AND ENVIRONMENTAL EDUCATION

When designing an environmental education program, it is impossible not to include values and ethics, since all environmental issues deal with individual and societal beliefs, attitudes, values, and actions. However, educators disagree about how and when to best address values and other "affective domain" subject matter in the curriculum.

> *In teaching about the environment, I began to better understand how I felt about certain issues.*
>
> —A Volunteer from Senegal

We believe that there is no such thing as "values free" education. Even if a teacher is not consciously trying to promote certain values or ethical messages, these often come through by what the teacher says, how he or she relates to the students, what materials he or she selects to use with the students, the role model he or she sets for the students, and other conscious and unconscious actions. If you don't consciously think about how you will deal with attitudes and values in your environmental education program, you could be setting yourself up for problems—especially if you are not prepared to facilitate the controversial discussions that might arise. Your environmental education program will be much more effective with a well-planned component focusing on attitudes and values. Studies have shown that environmental education programs that stress only awareness, knowledge, and skills do not necessarily help students change attitudes and behaviors that have an adverse impact on the environment. If the long-range goal of environmental education is to improve or maintain environmental quality, knowledge alone won't do the trick. In addition, by incorporating an attitude component into your teaching, you can help your students better understand themselves and help them develop morally.

But teaching values can be controversial and confusing for environmental educators. On one hand, we want to encourage behavior that has minimal impact on the environment; on the other hand we don't want to "brainwash" students into adopting the personal beliefs or values of their teachers. And we want to encourage the development of independent thinkers. In the following section, we'll explore values education and how students develop morally. We'll also look at the characteristics of the morally mature person and how an environmental education program can help students develop their own code of ethics.

Things do not change, we do.

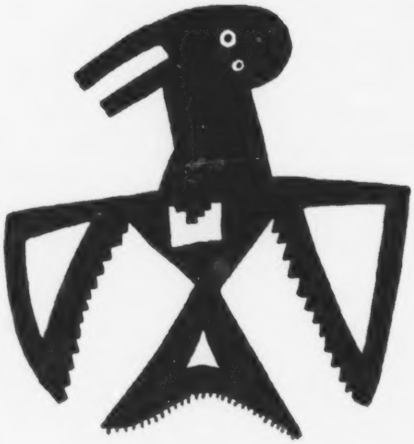
—Henry David Thoreau

VALUING VALUES

Our values are a combination of beliefs and attitudes—often deep-seated—that are determined by many factors, including environment, education, and personality. From kindness and love to tolerance and sharing, we pick up values from interacting with parents, teachers, and peers; from watching movies, television, and videos; and from society in general. Almost everything we do—from how we act to how we view life—is based on our own personal set of beliefs, attitudes, and values.

Many of us—adults and children alike—experience conflict and confusion about what we feel and how we should act. This is especially true about many environmental issues. On one hand, we want and need to satisfy biological needs for food, water, shelter, and clothing. On the other hand, we know that obtaining these things can harm the environment and potentially destroy our life-support systems. Reconciling individual, societal, and environmental needs is what environmental education is all about.

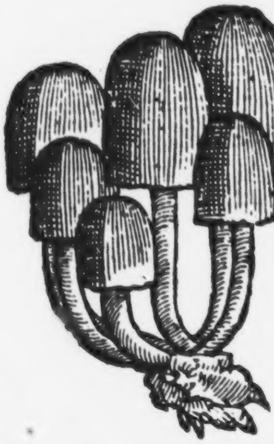
We suggest that you think about beliefs and values in two general categories: those that you, society, and the school agree on and those that are not universally accepted. For instance, most societies want to teach students to respect the rights of other citizens, to love their country, and not to steal or murder. There are other values and beliefs, however, that not everyone agrees are true or right or just. For example, some countries/societies advocate unequal treatment of ethnic minorities or women, or other beliefs that you might find objectionable. There are also many values and beliefs that you might feel are right, but that your host country colleagues would object to, including many environmental values and beliefs. For example, not everyone agrees that all living things have a right to exist, that land should be set aside as wilderness, or that citizens have a right to disagree with government policy.



Universal values should be (and are) inculcated in schools around the world. However, for those non-universal values and beliefs, we feel that it's important not to "tell" students what to think or to encourage them to follow your line of reasoning. Instead, we suggest that you try to help students examine their own values and beliefs, think for themselves, and develop their own standards of judgement. Many educators feel that the way to do this is by introducing activities very early that allow students opportunities to express their feelings, examine their values and beliefs and those of their peers, and learn to think critically. If students have such opportunities, many feel it can help them reach higher stages of moral reasoning where they are concerned about issues that go beyond their immediate self-interests and allow them to think more clearly about equality, social justice, and other complex social, political, and moral issues.

All progress has resulted from people who took unpopular positions.

—Adlai Stevenson



Many educators feel that the way to help students deal with internal conflict and build their own value systems is to use a values clarification process throughout their schooling. The goal of this approach is to help students make choices about what they believe, weigh pros and cons, evaluate consequences, accept that others have different beliefs, feel comfortable with the decisions they make, be willing to stand up for their beliefs, and take that final step to act on their beliefs.

Although it's important to let students "figure things out for themselves," there might be some environmental problems that are so pressing that you and your colleagues want to encourage a certain type of behavior through a system of rewards and punishments. For example, instead of allowing students to throw cans, bottles, and plastic in the trash, you might want to enforce recycling. And you might want to set up a program that encourages mass transit or walking instead of driving or getting rides in polluting cars. Although your students will ultimately have to think for themselves, there are some issues in which it's appropriate for educators to act as role models and reward certain behaviors. (Your students can still discuss the pros and cons of such programs in classes.)

Encouraging people to change behavior through a system of rewards and punishments is nothing new. Good behavior is rewarded (taking mass transit will save money) and bad behavior punished (tax on garbage that is not recycled). Students already take part in behavior modification in schools around the world—if they do well, they get a good grade, a star, or some type of positive recognition from the teacher. If they skip class, disrupt other students, or do poorly on exams, they get poor grades, a lecture from the teacher, or another type of punishment. Environmental education can help provide students with opportunities to take part in activities that reward good environmental behavior and discourage behaviors that harm the environment.

MORAL REASONING

Piaget found that children, as they develop intellectually, also experience several stages of moral development. For example, young children (ages 2-7) are just beginning to develop moral reasoning and are trying to understand rules, the difference between right and wrong, and the role of punishment. Many children in this age range "lie" and don't understand what's wrong with explaining what could have happened instead of what did happen. We believe that educators should introduce appropriate environmental behavior and respect for the environment beginning in these earliest years and continuing throughout a student's schooling. For example, children that are 4 and 5 can learn that littering is not acceptable behavior but that recycling is. By waiting until later years, students will have already formed attitudes that can be difficult to change. (In some societies littering is accepted behavior and needs to be addressed when children are older and can think about the pros and cons.)

From ages 7-11, children begin to make judgements about what is right and wrong, based on their own opinions. They also begin to challenge rules and understand what it means to lie. During this stage, children tend to view the world in opposites—something is either right or wrong, a person is either nice or mean. They also judge behavior in terms of what the consequences will be. At this stage, it's appropriate to begin discussing environmental issues that are controversial and have students think about how they feel and how other students feel about these issues. It's also appropriate to look at the behaviors of others and get reactions from the students about whether they agree or disagree with the behavior.

> *The ecologization of politics requires us to acknowledge the priority of universal human values and make ecology part of education and instruction from an early age, moulding a new, modern approach to nature, and at the same time, give back to [us] a sense of being part of nature. No moral improvement of society is possible without that.*
>
> —Mikhail Gorbachev

Older students (ages 11-15) begin to develop a distinct personality and a sense of self. At this stage, students start to understand that there are degrees of "crime" and degrees of "punishment." They learn that by relying on and cooperating with others, they can further their own goals. This is the stage when students begin to find a balance between societal constraints and self determination. It's a good time to have students begin to evaluate their own lifestyles in relation to environmental issues and to discuss how their actions affect the environment. At this stage, students can deal with more ambiguous and difficult environmental issues.

Another theorist, Lawrence Kohlberg, expanded on Piaget's work, which was limited to children under 12, and tried to explain how people form their beliefs about right and wrong and how they make moral judgements from childhood to early adulthood. Like Piaget, he found that people pass through stages of moral development on the road to higher moral reasoning, and that these stages correspond to the stages of intellectual development. At the highest stages, people not only see that there are different feelings about what is right or wrong, but that individuals can modify or change existing societal rules for the betterment of society. The decision to take action, based on personal principles, to protect the environment for future generations is an example of higher moral reasoning.

How can you tell where your students are on the continuum of moral development? In his book, "A Guide on Environmental Values," (UNESCO, 1985), Michael Caduto divides students into those who exhibit moral dependency, or lower stages of moral development, and those that exhibit higher stages of moral development, which he calls moral autonomy. Here are examples of specific behaviors from both categories:

RESPONSES INDICATING MORAL DEPENDENCY

I did it because:

- Mr. Kempke told me to (respect for authority)
- She did the same thing for me so I'm paying her back (payment in kind)
- They're all doing it (follow the leader)
- I was afraid she would hit me if I didn't do it (avoiding punishment)
- He said he'd share his lunch with me if I did it (seeking reward)
- I wanted to (if that is how I feel, then it's okay to do it)

RESPONSES INDICATING MORAL AUTONOMY

I did it because:

- We all agreed that do to it this way would be best for all of us (group contract, mutual understanding, reciprocity)
- She needed the comfortable chair more than I did because she was sick (equity—the demands of those with greater needs sometimes supersede those of people who are less needy)
- Even though it is more work for me to bicycle into school, I save energy each time I leave my car at home (health of the environment may supersede my comfort and convenience needs at times)
- I never could have faced myself if I had ignored his call for help (avoiding condemnation by one's own, internal moral conscience)
- They have as much right to be well-fed as we do (justice, equality)

As with all educational theories, there is much debate about how moral development actually occurs and if it is similar between sexes, cultures, and environments. We feel that schools need to play a leadership role in helping students develop sound moral reasoning skills to reach the higher stages of moral development.

As mentioned earlier, many educators shy away from moral education because of the perception that it will indoctrinate or brainwash students to think in certain ways. But the point of moral and ethical education is just the opposite—to help students think independently and openly, respect the opinions of others, evaluate their moral thinking, and reach their own judgements based on their own principles. Environmental educators need to integrate activities focusing on moral development with activities dealing with skills and content. (For examples of activities dealing with moral development issues, see Chapter 7.) One way to think about how to integrate moral education into your teaching is to work with other educators at your school and think about the characteristics that your community feels are important to be a good citizen of the world. Then lead activities that help students discuss and debate these characteristics. For example, the following list gives one view of the characteristics of a morally mature person:

1. **RESPECTS HUMAN DIGNITY**
   - Showing regard for the worth and rights of all persons
   - Avoiding deception and dishonesty
   - Promoting human equality
   - Respecting freedom of conscience
   - Working with people of different views
   - Refraining from prejudiced actions
2. **CARES ABOUT THE WELFARE OF OTHERS**
   - Recognizing interdependence among people
   - Caring for one's country
   - Seeking social justice
   - Taking pleasure in helping others
   - Working to help others reach moral maturity
3. **INTEGRATES INDIVIDUAL INTERESTS AND SOCIAL RESPONSIBILITIES**
   - Becoming involved in community life
   - Doing a fair share of community work
   - Displaying self-control, diligence, fairness, kindness, honesty, and civility in everyday life
   - Fulfilling commitments
   - Developing self-esteem through relationships with others
4. **DEMONSTRATES INTEGRITY**
   - Practicing diligence
   - Taking stands for moral principles
   - Displaying moral courage
   - Knowing when to compromise and when to confront
   - Accepting responsibility for one's choices
5. **REFLECTS ON MORAL CHOICES**
   - Recognizing the moral issues involved in a situation and applying moral principles when making moral judgements
   - Thinking about the consequences of decisions
   - Seeking to be informed about important moral issues in society and the world
6. **SEEKS PEACEFUL RESOLUTION OF CONFLICT**
   - Striving for the fair resolution of personal and social conflicts
   - Avoiding physical and verbal aggression
   - Listening carefully to others
   - Encouraging others to communicate
   - Working for peace

SUMMARY

In teaching for critical thinking, in the strong sense, we are committed to teaching in such a way that children learn as soon and as completely as possible how to become responsible for their own thinking.

—Richard Paul

The content of your environmental education program has to coincide with the developmental maturity of your students. By taking into account how students develop intellectually and morally, you can make better decisions about what is appropriate to teach at certain grade levels. You might find, through trial and error, that some activities and concepts are too ambitious for the grade level you work with. Or you might also find that the students in your classes are at different levels of moral development. By taking these differences into account, you can design more effective lessons that meet the individual needs of your students. It's also important to analyze your own teaching to determine how you introduce values into the classroom (by modeling certain behaviors, commenting on certain issues, and so on) and to determine whether you need to allow more time for students to evaluate how they feel and to develop their own set of values.

Many educators also feel it's important to help students focus on internal conflict and better understand their own value systems. To do this, many educators recommend using a values clarification process that helps students examine their values, weigh pros and cons, accept that others have different beliefs, and align actions with personal beliefs. (See Chapter 7 for more about values clarifications approaches.)

Although all domains are important, environmental education focuses primarily on the "knowledge" or cognitive domain and the "values and feeling" or affective domain. Each of the five components of environmental education outlined in Chapter 2 (pages 6-7) fall into one or both of these areas. *Awareness* focuses mainly on attitudes and feelings (the affective domain), helping students become aware of their environment, respond to environmental stimuli, and develop an emotional tie to the natural and built environment. *Knowledge* is the lowest level of the cognitive domain and gives students a basic understanding of how the environment functions and how people interact with the environment. *Thinking skills, citizen action skills, and participation* fall under all levels of the cognitive domain and several levels of the affective domain since they help students acquire the skills needed to identify and investigate environmental problems and to contribute to the resolution of these problems. And *attitudes and values* usually focus on the three highest levels of the affective domain, which include forming values, organizing a value system, and developing a consistent philosophy of life.

QUESTIONS TO THINK ABOUT . . .

1. *Does the content of your classes match the intellectual level of your students?*
2. *Do you go beyond simple recall and memorization in your classes by asking your students to analyze, synthesize, or evaluate?*
3. *Do your students take part in activities that focus on morals and ethics?*
4. *Do your students have an opportunity to discuss attitudes, values, and beliefs?*
5. *How are you helping your students develop their own environmental ethic?*
6. *Do you reward good environmental behavior?*
7. *Do you model good environmental behavior?*

> *A citizen of an advanced industrialized nation consumes in six months the energy and raw materials that have to last the citizen of a developing country [his or her] entire lifetime.*
>
> —Maurice Strong

THE COMOROS ISLANDS GOES ENVIRONMENTAL

Environmental education is alive and well on the three islands that make up Comoros—a small French-speaking country in the Mozambique Channel off the coast of Southeast Africa. Peace Corps Volunteers, working with their counterparts in schools and community groups, are helping to make a difference by taking part in formal and nonformal environmental education activities.

To help improve formal education, Volunteers have teamed up with counterparts to train primary school teachers to integrate environmental content in lesson plans. In addition to providing teachers with more information about the environmental issues affecting Comoros, they are encouraging teachers to use discovery teaching, innovative questioning techniques, and group cooperation in the classroom.

Volunteers are also working with local community groups called ULANGA to help them organize environmental exhibits and fairs and sponsor action-oriented projects for the community. These ULANGA groups have already conducted tree planting campaigns and clean-up and recycling drives and are planning to expand their environmental activities by helping to address environmental issues specific to each community.

5

PUTTING IT ALL TOGETHER: CREATING AN ENVIRONMENTAL EDUCATION FRAMEWORK

In the end, we conserve only
what we love. We love only
what we understand.
We understand only what
we are taught.

—Babr Dioum Dioum
Senegalese Poet

Drew is finally ready to integrate environmental education into his school's curriculum. He's surveyed his community and looked at environmental problems. He's outlined objectives that address the environmental problems he and his colleagues have identified. He's assessed his school and talked with students, teachers, and community leaders. He's met several times with other teachers that want to work with him on the project. And he's also assessed his students—their backgrounds, levels, ages, and abilities. But how does he take all of this information and use it to "environmentalize" his school's curriculum?

In this chapter, we'll look at how to pull everything together to design an environmental education program. Although a lot depends upon your specific situation, there are some common strategies that can help you put together an environmental education program that focuses on awareness, attitudes, knowledge, skills, and participation and is tailored to meet both your goals and the needs of your students.

Some of you will be trying to infuse environmental education into existing courses. For example, you might be an English teacher who feels that environmental content will help your students become environmentally literate while helping you teach English more effectively. Or you might be a secondary science teacher who wants to incorporate more relevant information about local environmental issues. Some of you, on the other hand, might have an opportunity to help infuse environmental education throughout the school curriculum or develop a course that focuses on environmental issues.

No matter what type of program you are working on, we urge you to work closely with your colleagues as you design your program. It's especially important to work with a curriculum development team if you are infusing environmental education throughout a curriculum.

THE BIG PICTURE—SCOPE AND SEQUENCE

Whether you are designing a course or revamping a curriculum, it helps to get a feel for the big picture by outlining which topics and skills you want to teach and when you want to teach them. If you're infusing environmental education into a primary curriculum, you need to decide what to teach at each grade level. If you're infusing environmental education into a one-year science or social studies course, you need to decide when to teach the concepts and skills throughout the year. (If you are developing a general environmental education program for a school system, the first step is to map out a curriculum framework that lists the fundamental principles guiding your program. See the Appendix for samples of environmental education curriculum frameworks.

In most schools where you teach, there will be an existing curriculum or syllabus outlining what you should teach. It's likely that this curriculum does not include environmental education—or if it does, the topics might be scattered throughout the year and not focus on those issues you've identified as critical to your community and students. We suggest that you first outline what you want to teach and when you think it makes sense to teach it, based on your environmental assessment and your analysis of the school and your students (see Chapter 2). Then try to match your objectives to the ones that are outlined in the existing school curriculum. (This holds true whether you are trying to infuse environmental education into a science class or trying to infuse environmental education throughout the entire curriculum.)

The easiest way to take what you want to teach and figure out when to teach it is to create a scope-and-sequence chart. The chart lays out the amount of material you can effectively include in a course or curriculum (the scope) and it outlines the order in which the content should be taught (the sequence).

WHAT TO TEACH—THE SCOPE

The scope of your environmental education curriculum outlines the content, skills, and values education you hope to cover in your course or throughout the curriculum. If you've followed the planning process outlined in Chapter 2, you already have a good feel for the content that should be included. To get started, write the main topics you've identified and the objectives that you've come up with. Include any prerequisites you feel you need to teach so that your students have the necessary background information. (See pages 67-68 for a sample.)

Fill in any content holes by reviewing your environmental assessment and looking through other resources that outline environmental education courses and curriculum. For example, *Essential Learnings*, a resource book published by the North American Association for Environmental Education, outlines major concepts, topics, and ideas associated with environmental education. It can help you build a scope and sequence, although you still need to tie the content to your environmental assessment and what you think is most critical to cover. (See the Bibliography for additional references that can help you infuse environmental education into an existing curriculum.) It's important not to stray too far from the original objectives you've outlined that tie directly to your own community's environmental problems.

Don't limit your environmental content to "pure science." Although environmental education does include a big chunk of what we normally think of as science, such as ecology, natural history, air and water chemistry, and energy, it also includes information about the interactions between humans and the environment. Philosophy, psychology, history, geography, and language are examples of other subject areas that easily fit into an environmental education curriculum.

When developing the scope of what you want to teach, it's also critical that you outline the skills that your students need to learn, in addition to the subject matter. (Your objectives should include the thinking skills you feel are important.) As mentioned in Chapter 1, thinking skills and environmental education go hand in hand. From voting to shopping to choosing a pet, we make environmental decisions every day that influence the environment and involve thinking skills. But many of us haven't had the opportunity to practice thinking in a critical or creative way—and when it comes to making decisions about environmental issues, we're at a loss. It would be impossible to find an environmental issue that has been resolved without the people involved using some type of critical thinking process to find solutions. And that's why helping students learn how to think (not what to think) is one of the cornerstones of environmental literacy.

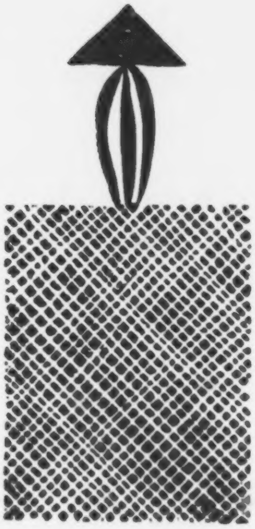
Teaching thinking is an exciting challenge, but it's up to you, your colleagues, and your school system to determine which skills to teach, when to teach them, and how to teach them. Both critical and creative thinking are important, and both can be taught through environmental education. Critical thinking is "reasonable, reflective thinking that is focused on deciding what to believe or do." Critical thinkers try to understand and be aware of their own biases, to be objective and logical, and to understand other points of view. Creative thinking is being able to come up with new ideas or possibilities—whether it relates to solving an environmental problem or writing a short story.

There are dozens of lists of important thinking skills that educators feel students should develop. As far as environmental education goes, one way to choose what you think is important is to look at the skills that students will need to investigate and solve the environmental problems you outlined in Chapter 2. Depending on the level of your students, you can also look at the skills students would need to solve any environmental problem, including being able to:

- recognize environmental problems
- define environmental problems
- listen with comprehension
- collect information
- organize information
- analyze information
- generate alternative solutions
- select a solution
- develop a plan of action
- implement a plan of action
- evaluate a plan of action

Another way to determine which thinking skills are important for you to focus on in your teaching is to create a list of those characteristics you feel best typify a critical thinker. For example, here are some of the characteristics that some would say indicate a person thinks critically:

- is open-minded
- takes a stand on an issue or changes a position, based on the evidence
- looks at an entire situation, not isolated pieces of a problem
- tries to find out why a problem exists or what the reasons are behind something
- looks for alternatives
- keeps the problem in focus throughout decision-making
- looks for information and gathers it from a variety of sources
- analyzes the quality of the information (credibility of the source, etc.)
- defines the problem clearly
- is sensitive to the feelings and knowledge level of others (*)



The highest result of education is tolerance.

—Helen Keller

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* *(Adapted from "Logical Basis for Measuring Critical Thinking Skills" by Robert H. Ennis,* Educational Leadership, *ASCD, October 1985.)*

In the Appendix, we've included a sample list of critical thinking skills that might be helpful as you plan an environmental education program. The skills correspond to Bloom's taxonomy. We recommend that you list a limited number of core thinking skills to emphasize in your teaching and that you try to reinforce these skills several times throughout the course of a year.

Finally, it's also important to include environmental ethics and values clarification in your scope. As mentioned earlier, having students develop an environmental ethic and discuss values is an important goal of an environmental education program. (See Appendix 4 for an example of a scope and sequence listing understandings that focus on environmental ethics developed by Bill Stapp and Dorothy Cox. Also see Chapter 7 for examples of values and attitude activities.)

WHEN TO TEACH—THE SEQUENCE

Once you've outlined what you want to teach, it's important to sequence your objectives to fit the intellectual and moral development of your students. In general, try to:

- start with simple concepts and thinking skills and move to more complex as students get older
- focus on concrete activities in early grades and move to more abstract ideas as students mature
- keep prerequisite knowledge and thinking skills in mind
- present topics chronologically and/or logically, where appropriate. (For example, you would probably want to cover some local natural history before discussing food webs so that everyone is familar with the plants and animals being discussed.)

Here's an example of a sequence of topics that might be appropriate for units on soil erosion and desertification in The Gambia—one for grade 7 and one for grade 8:

GRADE 7

- Investigation of soil and its properties
- Life in the soil
- What is soil erosion?
- Causes of soil erosion
- Consequences of soil erosion
- Reducing soil erosion

GRADE 8

- Case study of Sahelian desertification problems, including definition
- Causes of desertification, including review of soil erosion
- Social, ecological, and economic consequences of desertification
- Solutions to desertification
- How Gambians feel about climate/land changes in their country
- Success stories

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MORE ABOUT CURRICULA AND INFUSION

When you infuse environmental education into an existing curriculum, you need to fit your objectives into the curriculum. (It's important that you map out a general scope and sequence for the environmental content and skills you want to infuse before you start. It will make the task easier if you already know what you want to teach and in what order it should be presented. Whenever you infuse environmental education into an existing curriculum, you will be working with two scope and sequences—the one for the material you want to infuse and the one that is currently being used in the school or class.)

The following steps are adapted from "A Guide to Curriculum Planning in Environmental Education" by David Engleson (Wisconsin Department of Public Instruction, 1987). We recommend that you follow the steps to make sure that both the original and the new objectives are compatible and achievable.

1. Select the topic you want to infuse into the existing curriculum outline.

   Example: coral reef destruction

2. Identify subject areas in the curriculum that relate to the topic you want to infuse.

   Example: topics in social studies curriculum dealing with how people use the environment; topics in science curriculum dealing with marine ecosystems, food webs, ecology, and so on.

3. Add the environmental education objective(s), based on the topic you want to infuse, to the existing objective and new content.

   Example of new objectives to infuse: Describe three ways to prevent coral reef destruction. List the problems facing the coral reef, starting with the most serious. List five community fishing rules that will ensure a sustainable harvest of coral reef fish.

4. Describe new instructional techniques to teach the new objective(s).

   Example: field trip to the coral reef; survey of how the coral reef has changed over time; guest speakers from the community to talk about economics, fishing, and ecology; homework assignment to establish fishing rules

5. Identify any new skills that are needed to meet the objectives.

   Examples: observing and recording; establishing priorities; surveying and interviewing; analyzing

6. Identify new resources needed to achieve the environmental education objectives.

   Examples: resource materials about coral reef problems and solutions; reference materials about coral reef habitats; guest speakers from the community

> *The major problems in the world are the result of the difference between the way nature works and the way [people] think.*
>
> —Gregory Bateson

7. Describe any related activities and topics that could be taught with the new unit.

   Examples: fish farming, ecotourism, and so on

AN INTERDISCIPLINARY APPROACH TO LEARNING

Although many schools around the world organize their curricula within "traditional" disciplines such as math, science, and health, some schools are trying a more integrated and interdisciplinary approach. An interdisciplinary scope and sequence is focused on a unifying topic or theme and looks at that theme through the eyes of several different disciplines. We recommend this approach if you have the opportunity to develop your own environmental education course. By developing units based on themes and incorporating a variety of discipline emphases throughout, you can help students get a feel for how learning fits together and the interdisciplinary nature of environmental issues.

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For Example, a Unit on Flight Could Include the Following Topics:

Social Studies

- history of flight
- occupations in flight
- how flight has changed society
- careers in flight

Philosophy/Psychology

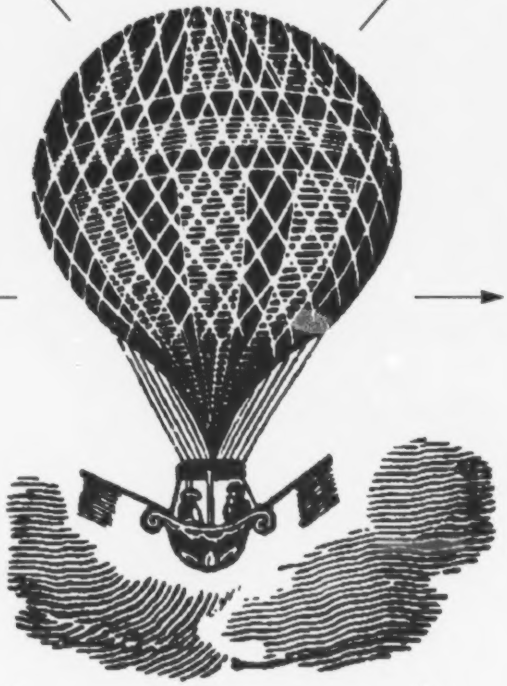
- fight or flight
- ethics of airport noise
- why we fly?

Science

- bird flight patterns
- aerodynamics
- insects that fly
- space flight

Math

- scale models
- economics of flying
- angles for smooth flying



FLIGHT

(organizing theme)

Language Arts

- biographies of famous pilots
- flying heroes
- flight poems

The Arts

- DaVinci's designs
- Japanese and African kites
- films on flight
- mobiles
- music inspired by flight
- folk stories about flight

THEN NARROW IT DOWN WITH GUIDING QUESTIONS:

- What flies?
- How and why do things in nature fly?
- What has been the impact of flight on human beings?
- What is the future of flight?
- What are the environmental impacts of flight?

> *The first day or so we all pointed to our countries. The third or fourth day we were pointing to our continents. By the fifth day we were aware of only one earth.*
>
> —Sultan Bin Salman al-Saud
> Astronaut

(Adapted from ASCD Interdisciplinary Curriculum: Design and Implementation, *edited by Heidi Hayes Jacobs, 1989.)*

AND A UNIT ON RAIN FORESTS MIGHT INCLUDE THE FOLLOWING TOPICS:

SCIENCE

- characteristics of the habitat
- plants and animals that live in rain forests
- agro-forestry and slash-and-burn agriculture
- soil comparisons
- geologic history of rain forests
- ecological relationships in rain forests

LANGUAGE ARTS

- biographies of scientists and historians that have studied rain forests and indigenous peoples
- writings by famous authors
- keeping a journal
- short stories about animals of the rain forest

MATH

- interpreting graphs and data from research projects
- scale models of the layers in a rain forest
- interpreting surveys
- economic issues related to forestry and ecotourism

> *I am trying to save the knowledge that the forests and this planet are alive, to give it back to you who have lost the understanding.*
>
> —Paulinho Paiakon
> Leader of the Kayapo
> Indians of Brazil

PHILOSOPHY/ETHICS

- displacement of indigenous peoples
- how native cultures view the earth
- comparisons between lifestyles in urban areas and those in rain forest communities
- how much is a rain forest "worth"?

SOCIAL STUDIES

- history of rain forest exploration
- comparisons of the lives of native peoples in Africa, Asia, and South America
- causes of deforestation

THE ARTS

- rain forest paintings and crafts
- films on rain forests and their peoples
- music inspired by rain forests
- famous photographers and their work

GEOGRAPHY

- maps showing where rain forests are found
- routes of explorers
- in-depth study of rain forest countries (Brazil, Belize, and so on) and how these countries are influenced by their forests

AGRICULTURE/EXTENSION

- methods of agro-forestry
- history of food production in rain forests
- analysis of foods that originated in the tropics
- comparison of small and large-scale slash-and-burn agriculture

Experts say we are losing an area of rain forest the size of Pennsylvania every year.

GUIDING QUESTIONS MIGHT INCLUDE:

- Where are rain forests found?
- Who and what live in rain forests?
- How do people depend on rain forests and how have they depended on them in the past?
- How do people study rain forests?
- What is the future of rain forests?

The next steps would be to outline the objectives and activities that can help students investigate the questions. Working out a matrix based on Bloom's taxonomy (page 45) can help make sure that higher level thinking skills are included in the curriculum outline. (See Chapter 7 for more about activity development.)

Depending on your situation, you might also want to develop modules, courses, or workshops centered around specific aspects of environmental education, such as a module on decision-making, values, or environmental ethics. You could also work closely with a colleague to create an interdisciplinary day of team teaching. For example, once a week, you might combine science and social studies to conduct activities that focus on environmental issues.

SAMPLE CURRICULUM OUTLINE

On pages 67-68, we've included a sample of a curriculum outline based on the example in Chapter 2, which focuses on coral reefs. It shows how the objectives listed on page 24 could be incorporated into a variety of disciplines and grade levels. Although this is a simplified example, it shows that some of the concepts and skills are more appropriate for upper grades than lower grades and that many of the concepts need to be reinforced throughout the curriculum to achieve the intended goals. But remember that the grade level prescriptions outlined here will vary from country to country. (See Section 2 in the Appendix for two sample curriculum frameworks. Also see Section 6 for an outline of the four major goal levels of environmental education developed by Harold Hungerford, Ben Payton, and Richard Wilke to help guide curriculum development in environmental education.)

> *In terms of species richness and biological productivity, coral reefs are the tropical forests of the sea.*
>
> —World Wildlife Fund

CORAL REEFS THROUGHOUT THE CURRICULUM

ENVIRONMENTAL PROBLEM: *Destruction of coral reefs and drastic decrease in numbers of marine creatures. Causes include sedimentation from soil erosion; overfishing from using traditional methods as well as poisoning and dynamiting; tourists and shop keepers breaking off chunks of coral; boat anchors smashing coral; overharvesting of sea turtles and their eggs; and pesticide run-off from agricultural fields.*

GRADES K-2

SCIENCE

- recognize creatures that live in the coral reef
- identify living and non-living components of the marine community

LANGUAGE ARTS

- use adjectives to describe some of the creatures that live in the coral reef
- sing a song about coral reef creatures that describes relationships between the animals

MATH

- use coral reef subject matter to compute simple math problems

HEALTH

- describe the major food groups and discuss what types of food people get from the ocean

ART

- create a coral reef mural showing people and wildlife

GRADES 3-4

SCIENCE:

- explain how a coral reef forms
- explain why reefs are important to reef animals
- describe some of the important fish and other animals that live on the reef
- explain why the reef is important to you

LANGUAGE ARTS AND SCIENCE

- take a trip to the coral reef to look at the different types of animals and plants and problems facing the coral reefs
- write a letter to a friend describing your trip
- describe the coral reef in your journal

ART

- draw a picture of your favorite marine creature

GRADES 5-6

SCIENCE

- define food webs; compare food webs in a coral reef to those of other habitats
- define pollution; describe how pollution affects plants and animals that live in and near the reef
- compare and contrast adaptations of coral reef fish
- explain why sunlight is important to the reef

HOME ECONOMICS

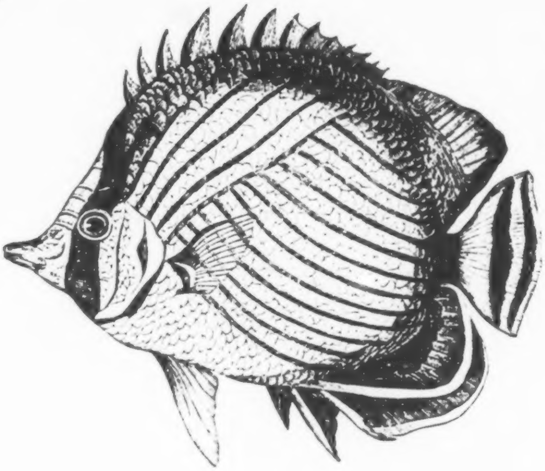
- describe how people throughout history have relied on sea turtles for food
- define endangered and discuss why sea turtles are endangered

SOCIAL STUDIES

- read and compare accounts of sea turtle harvesting; discuss feelings about sea turtle declines

ART

- create a food-web bulletin board



GRADES 7-8

HOME ECONOMICS:

- describe the types of reef fish people in the community depend on; prepare recipes using the most common fish
- discuss the consequences of overfishing

SCIENCE

- explain how coral reproduces and how it is important to other creatures on the reef
- collect water samples from the reef and analyze them using simple chemical tests; explain how water quality affects coral polyps
- point out examples of soil erosion in the community and explain what causes soil erosion; describe how soil erosion can kill a reef

MATH

- make a graph showing declines in fishing resources
- estimate future fish harvests from given data

LANGUAGE ARTS

- write poetry about some aspect of the coral reef
- write a fictional story about "the day the coral reef died"

GRADES 9-10

LANGUAGE ARTS

- write an essay about personal feelings relating to the coral reef
- write an essay about the connection between being a responsible citizen and taking care of the environment

ART

- create a coral reef bulletin board for the school or library explaining problems and solutions

SCIENCE

- listen to guest speakers explaining about fish declines in the coral reef and compare the content of their talks
- list several ways to prevent fish declines
- visit the coral reef without damaging it
- take part in a role play that demonstrates the competing uses of the coral reef

VOCATIONAL

- implement soil conservation techniques on sample plots
- explain how soil erosion affects marine ecology
- describe and demonstrate safety rules for applying pesticides; describe the pros and cons of using pesticides to control pests

GRADES 11-12

SOCIAL STUDIES

- survey community members to find out how the coral reef has changed over time
- work with other classes to sponsor a public forum about coral reef problems and solutions
- develop an ecotourism plan for your island; describe how a healthy coral reef can benefit the economy

SCIENCE

- analyze population data from the reef showing numbers for fish, coral, mammals, and other creatures
- define global warming; describe how global warming might affect your island; describe how warming trends could affect reefs

LANGUAGE ARTS

- write and present a persuasive argument in support of coral reef protection

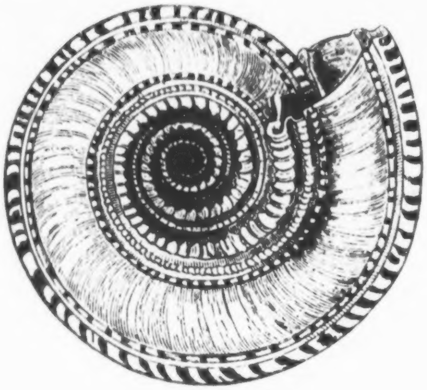
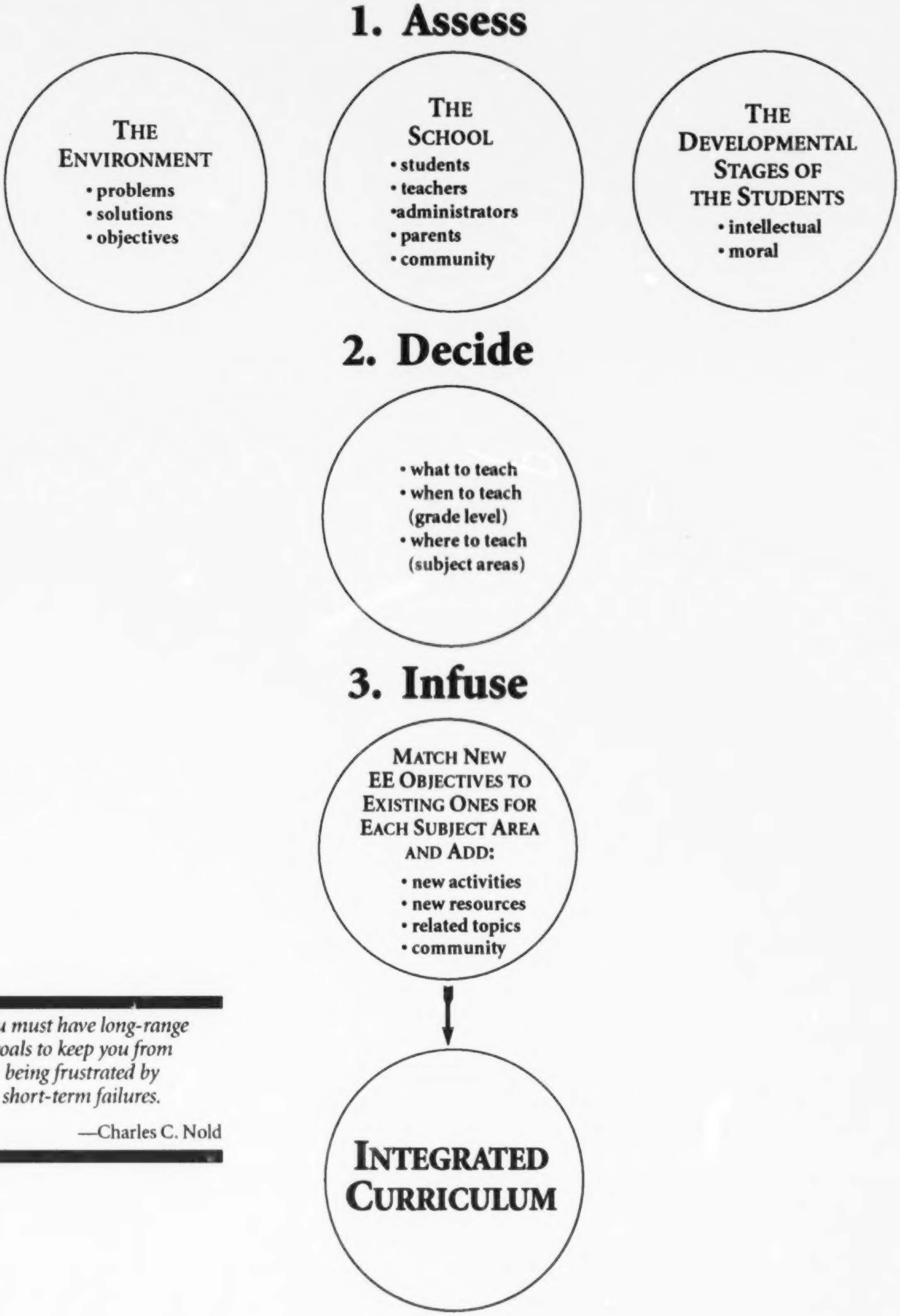


FIGURE 1. INFUSION


1. Assess
THE ENVIRONMENT
• problems
• solutions
• objectives
THE SCHOOL
• students
• teachers
•administrators
• parents
• community
THE DEVELOPMENTAL STAGES OF THE STUDENTS
• intellectual
• moral
2. Decide
• what to teach
• when to teach (grade level)
• where to teach (subject areas)
3. Infuse
MATCH NEW EE OBJECTIVES TO EXISTING ONES FOR EACH SUBJECT AREA AND ADD:
• new activities
• new resources
• related topics
• community
INTEGRATED CURRICULUM

> *You must have long-range goals to keep you from being frustrated by short-term failures.*
>
> —Charles C. Nold

GRADE-LEVEL EMPHASES ON ENVIRONMENTAL EDUCATION OBJECTIVE CATEGORIES

LEVEL	MAJOR EMPHASIS	MINOR EMPHASIS
K-3	Awareness Attitudes	Knowledge Skills Participation
3-6	Knowledge Attitudes	Awareness Skills Participation
6-9	Knowledge Skills Attitudes	Awareness Participation
9-12	Knowledge Skills Participation Attitudes	Awareness

Adapted from A Guide to Curriculum Planning in Environmental Education *by David Engleson (Wisconsin Department of Public Instruction, 1985)*

SUMMARY

Creating a scope and sequence helps you outline what you want to teach and when you should teach it. It also helps you plan so that your objectives build on each other from one grade level to the next. It's important to keep content, values, and skills in mind when developing a scope and sequence, and to go back to the original objectives you outlined after assessing the environmental situation in your community and country.

Once you have a scope and sequence, you can design an instructional program that will teach the objectives you've outlined in a creative and effective manner. In the next chapter, we'll look at a variety of creative teaching strategies. And in Chapter 7, we've included a variety of model activities that use these strategies and will give you ideas about how to create the most effective program to meet your students' needs. For more about curriculum development, see the resources listed in the Bibliography.

> *It is more important to know where you are going than to get there quickly. Do not mistake activity for achievement.*
>
> —Mabel Newcomber

QUESTIONS TO THINK ABOUT . . .

1. *Are your objectives appropriate for the level of your students?*
2. *Have you identified courses and grade levels where these objectives can be taught?*
3. *Do your objectives tie directly to environmental problems you've identified in your community?*
4. *Have you outlined content, values, and skills that you will be teaching?*
5. *Have you reviewed existing curriculum materials and followed a logical process for infusing environmental education into the existing curriculum?*
6. *Have you worked backwards to make sure students have the knowledge, skills, and attitudes needed to achieve objectives in higher grades?*

> *The irony of the matter is that future generations do not have a vote. In effect, we hold their proxies.*
>
> —Charles Hitch

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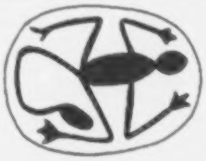
Protecting Golden Lion Tamarins

In Brazil, an environmental education project sponsored by World Wildlife Fund (WWF) and local organizations is helping to protect the endangered golden lion tamarins and the forest habitat where the tamarins live. Specifically, the project was designed to reduce deforestation in the lowland areas around the reserve; to ensure permanent conservation of the remaining privately owned forests in the area; to reduce the threat of damaging fires in the region's forests and cleared areas; to reduce the illegal trade of tamarins; and to reduce illegal hunting within the reserve.

As a first step, to find out how much the local community knew about the problems and solutions, project coordinators sent questionnaires to local landowners and school children, and interviewed other local residents to ask them about the golden lion tamarins and their feelings about the forest and wildlife. They also conducted informal interviews with local leaders and set up community planning teams. They ended up with an integrated environmental education program that included classroom activities for third and fourth grade students (most local students do not go beyond fourth grade); lectures for local authorities, teachers, conservation groups, farmers' groups, and high school and university students; educational field trips to the reserve; student essay and art contests; two-day teacher-training workshops on ecology and environmental education that were conducted in the forest; an environmental parade; a play about the golden lion tamarin; and a local media campaign that included posters, television and radio spots, T-shirts, and slide shows.

Although the project is not over, there have already been some positive results. People living in the area where the golden lion tamarins live have developed more positive attitudes toward the tamarin after two years of the environmental education project. The project has also affected people's attitudes about other types of wildlife and helped encourage local landowners to set land aside for endangered wildlife. For more formation about the golden lion tamarin project, write to World Wildlife Fund, 1250 24th Street, NW, Washington, DC 20037.



6

TEACHING TIPS AND TRICKS: STRATEGIES THAT WORK

Theories and goals of education don't matter a whit if you don't consider your students to be human beings.

—Lou Ann Walker

As a first year science teacher, Sophia was determined to make her lectures dynamic—especially when she was talking about the environmental problems in her country. She researched each topic, often double-checking her information to make sure that what she said was accurate. She included in-country examples and statistics, and inserted quotes and humor whenever she could. Just the other day she had given what she thought was an outstanding lecture about desertification in Africa. But something was wrong. Many of her students seemed to "zone out" during her presentations, and they performed poorly on some of her exams, even though they did well on exams in other classes. Others, who did well on the exams, really didn't seem to understand the underlying concepts she was trying to get across. It seemed as though the more information she packed in, the less effective she was.

What Sophia didn't realize is that not all people learn in the same way, and that lectures aren't effective for all ages or types of learners. She also didn't realize that many teachers tend to teach in a style that is most comfortable to their own learning preferences, even though that style is not effective for all students. Many teachers also teach the way they were taught—and in many cases lectures, or "chalk talks," are emphasized more than other methods. Sophia felt most comfortable with lectures and assumed that her students would feel the same way.

In this chapter, we'll focus on a variety of strategies for incorporating current educational theory into your environmental education lesson plans, with the goal of making your lesson plans as dynamic and effective as possible. Specifically, we will look at:

- different learning styles and intelligences and what these mean for your teaching
- the experiential learning cycle and how discovery learning can make your teaching more effective
- lesson plan basics and models
- recognizing student misconceptions
- effective ways to introduce controversial issues in the classroom
- strategies for teaching thinking skills, including questioning techniques
- the value of cooperative learning

The strategies outlined in this chapter will help you develop more effective environmental education programs that make use of the current research on teaching and learning strategies. In Chapter 7, we've included a variety of activities that make use of the strategies outlined in this chapter. You can use the activities as models to help you create your own activities, adapting them to fit your individual needs.

Many of the educational theories and activities presented here were developed in North America, Australia, and Europe, and may require adaptation for use in your situation. They may also require some time before they are accepted by your colleagues and students. In many countries, including many parts of North American and Europe, chalk talks and rote memorization of facts typify teaching. In addition, teachers are often poorly paid and trained and have limited time to learn new teaching strategies. Like many other Peace Corps endeavors, lasting change often comes slowly. Be patient. It's also important to check in-country theories and practices to ensure that what you implement is appropriate and effective for the culture.

Learning Styles and Multiple Intelligences

Mary Jo Larson, an Education Specialist at Peace Corps, uses a video camera in her workshops to illustrate the point that many of us feel most comfortable with a certain learning style. Holding up a video camera, she asks participants to think about what they would do if someone gave them a new and unfamiliar piece of equipment. She asks if they would be most apt to:

- talk to someone about it
- watch someone use it and listen to what they say about it
- read the instructions
- just pick it up and try it

In tallying the responses, she finds that some would pick up the camera immediately and "fool around with it." Others would read the instructions from start to finish before even taking it out of the box. Some say they would talk to people who had used a similar camera before trying it out, and others say they would watch someone use it before trying it themselves.

Mary Jo uses this simple demonstration to reinforce the idea that all of us learn in different ways and have definite learning preferences. In *The 4MAT System—Teaching to Learning Styles with Right/Left Mode Techniques* (Excel, Inc., 1980), author Bernice McCarthy describes four general types of learners:

- those that learn best by relating to people
- those that learn by watching and listening
- those that learn through intellectual understanding
- those that learn by doing

> *Every human being is intended to have a character of [his/her] own; to be what no others are, and to do what no others can do.*
>
> —William Ellery Channing

Although some teachers instinctively include activities that cater to a variety of learning styles, many of us tend to teach in the style that we find most comfortable. In Sophia's case, she learned best by listening and taking notes. So, she felt most comfortable lecturing to her students—a method that is teacher directed with little input from the students. The chalk-talk method of teaching allows the teacher to be in control throughout the lesson; however, it often inhibits student involvement. On the plus side, it does provide the opportunity to convey a lot of information quickly and in many cases, efficiently. And many students are very interested in facts and need the teacher to demonstrate, lecture, explain, and clarify.

What type of learner are you? David Kolb, an educator who has worked extensively with adult education, has developed a simple survey or learning styles inventory that helps you determine your preferred learning style preference. By filling out a questionnaire and tallying the results, you can find out more about your individual learning style. See the box on the next page for how Kolb generally describes the characteristics of the four groups of learners. Also see the ICE Manuals, *Teaching Training* and *Nonformal Education Manual* for more about the Kolb survey and theory.

Every tale can be told in a different way.

—Greek Proverb

THOSE THAT LEARN FROM FEELING

Learners in this group tend to be more sensitive to feelings and people, and they learn best from specific experiences. They don't find theoretical approaches as helpful as talking with peers, discussing experiences, and exchanging feedback. This group, in general, tends to be more oriented toward peers and less toward authority. In learning situations they are open-minded, intuitive, and adaptable.

THOSE THAT LEARN BY WATCHING AND LISTENING

These learners rely heavily on careful observation in making judgements and prefer learning situations that allow them to be objective observers. In general, this group relies on patience, objectivity, and careful judgement and is hesitant about taking action. They rely on their own thoughts and feelings to form opinions, view things from different perspectives, and often look for the meaning of things. Learners in this group enjoy lectures and demonstrations.

THOSE THAT LEARN BY THINKING

The third group of learners take an analytical, conceptual approach to learning that relies heavily on logical thinking and rational evaluation. This group is more oriented toward things and symbols than people. They learn best in authority-directed, impersonal situations that emphasize theory and systematic analysis. They are often frustrated by "discovery" learning approaches and prefer systematic planning and learning.

THOSE THAT LEARN BY DOING

The last group of learners are the doers. They rely heavily on experimentation and learn best when they can engage in projects or small group discussions. They generally dislike lectures and other passive learning activities. Individuals in this group like to get things done and don't mind taking risks.

Another way to think about learning styles is to think about how students use their senses to find out new information. For example, some educators divide students into kinesthetic learners (those who learn best by doing—running, jumping, walking—and who learn best through simulation and role plays); auditory learners, who remember what they hear; visual learners, who remember what they see or read; and tactile learners, who need to get their hands "dirty" by building things and working directly with objects and models. Students, in addition to having one or more of these perceptual strengths, may also be more analytical or global. Analytical learners do best with step-by-step instructions, while global learners often need to see the big picture before understanding the facts.

Kolb, McCarthy, and other learning style educators emphasize that all of us learn in a variety of ways, but have certain preferences. By recognizing your own learning style preferences and those of your students, you will be better able to design lesson plans that cater to a variety of learning styles and don't just promote your own natural preferences. (See page 80 for how to apply Kolb's learning theory to a four-step model for lesson planning.)

Recognizing Student Strengths

Keeping learning styles in mind as you develop lesson plans will help maintain your students' interest and help them excel. It's also important to recognize that students have different natural strengths. Howard Gardner, an educator at Harvard, says schools have traditionally tested for mainly two forms of intelligence—the logical and linguistic. Although Gardner says that measuring the scientific, mathematical, and language abilities is important, he emphasizes that it is equally important to recognize the other measures of intelligence. This is especially important to environmental education, which relies on a variety of individual strengths to help solve complex problems. Below are the seven broad categories of intelligences Gardner describes. Do you recognize any of your students' strengths—or your own?

Linguistic: the ability to understand and use words (fullest expression in poets, storytellers, writers)

Environmental connection: write a story or newspaper article about an environmental issue or natural history topic

Logical/Mathematical: the ability to reason abstractly and conceptually using deductive or inductive modes of thought (scientists, mathematicians)

Environmental connection: analyze data or solve an environmental problem

Spatial: the ability to perceive the world of objects accurately, imagine transformation and modifications of what one sees, and recreate visual experiences from memory (architects, sculptors, navigators, designers, artists)

Environmental connection: make a model of a more efficient solar car

Musical: the ability to recognize variations of tone and pitch, and a capacity to combine tones to create new sounds (composers, conductors, singers)

Environmental connection: express feelings by writing a piece of music inspired by the natural environment or by writing a song that can educate others about an environmental issue

Kinesthetic: the ability to use one's body and muscle structure in a coordinated, planned way (dancers, athletes, mimes)

Environmental connection: plant trees, play an environmental running game, or perform an environmental dance

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> *Everything [people], animals, trees, stars, we are all one substance involved in the same terrible struggle. What struggle? . . . Turning matter into spirit. Zorba scratched his head and said, "I've got a thick skull, boss. I don't grasp these things easily. Ah, if you could dance all that you've just said, then I'd understand. . . . or if you could tell me all that in a story, boss."*
>
> —from Zorba the Greek

INTERPERSONAL: the ability to deal effectively with others (teachers, politicians, psychologists)

Environmental connection: take part in role plays and simulations or get involved in a community outreach project involving an environmental issue

INTRAPERSONAL: the ability to know one's own feelings, to understand one's own behavior (having a model of yourself and using that model to solve problems)

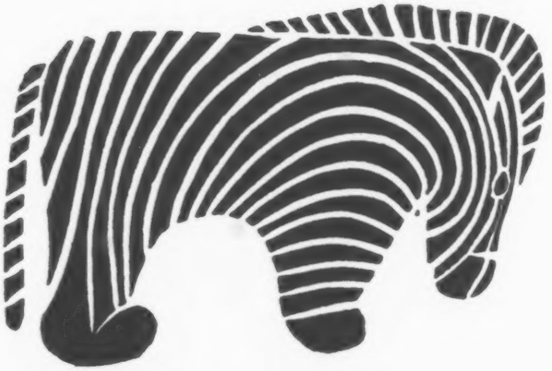
Environmental connection: keep a personal journal about your feelings concerning environmental issues

According to Gardner's definition, everyone has all intelligences, but not in the same strengths. Gardner suggests that students concentrate on their strengths, but try to build on their weaknesses. He also says that it's important to understand and accept that students can't learn everything and that providing students with an opportunity to excel in each area will help build self esteem and lifelong skills.

Gardner is just one of many researchers looking at intelligence. Another, Robert Sternberg, challenges the notion that "smart is fast." He argues that many smart people are reflective, take their time to figure out problems, and keep at something until they get it right. However, most schools around the world test for "quickness" with timed tests throughout a student's schooling. He also says that traditional tests don't help teachers understand how well a student can critique and analyze a problem or argument. He says that a lot of people are "very good analytically, but they just don't have good ideas of their own."

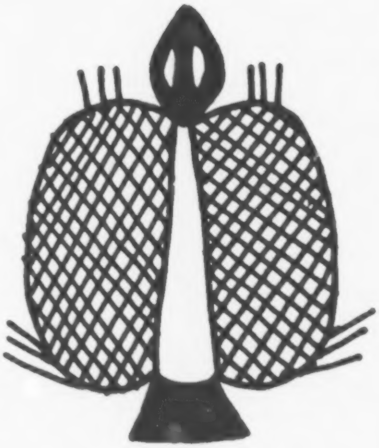
As far as environmental education is concerned, it's important to help students realize their potential and not stereotype students as "smart" or "stupid" and assume that if they do well on an IQ test, they will become an environmentally responsible citizen or excel in school or in life ater school. And likewise, if a student does poorly on tests, it doesn't mean the child is stupid or will not be a productive member of society. Intelligence is a complex stew of many types of mental abilities and is influenced by a variety of factors. It is important to help all students feel that they have the potential to learn and to excel!

> *There is no single horizontal capacity such as memory, perception, problem solving, learning, or originality that cuts across diverse contents. Rather, individuals can have a good or bad memory, can be rapid or slow learners, can exhibit novel or stereotyped thinking in any one of these intelligences. . . . In this view, there is not general "brightness" or "smartness." People can be "smart" or "dumb" in one area, but this tells us nothing about their intelligence in other domains.*
>
> —Howard Gardner



CREATIVE LESSON PLANNING AND ACTIVITY DEVELOPMENT

By keeping learning styles in mind, as well as students' individual strengths, you can create more effective environmental education lesson plans. There are many ways to design lessons, but all require that you set aside time to plan so that you know where you are going, how you will get there, and how you will know if you have succeeded. By planning ahead, you will be able to incorporate a variety of approaches and techniques, increase student involvement, accomplish your objectives, and prepare materials needed for the lesson. The most important step is to clearly outline your goals (see page 23 in Chapter 2) and then write specific behavioral objectives for each lesson that will accomplish your goals.



A CLOSER LOOK AT OBJECTIVES

There are often three levels of writing behavioral objectives: your overall program objectives, the specific course objectives, and the actual lesson plan objectives. Before writing lesson plan objectives, you'll need to map out your overall program and course objectives. The time to do this is when you develop your scope and sequence (see Chapter 5).

Here's a sample of each level of objectives:

PROGRAM OBJECTIVE: By the end of middle school, students will be able to list the major environmental issues facing Sri Lanka and describe the causes and consequences of each issue.

COURSE OBJECTIVE: By the end of level six, students will be able to explain the causes of desertification, discuss how desertification affects people living in and around desertified areas, and describe several possible solutions that could help slow desertification.

LESSON PLAN OBJECTIVE: By the end of this three-day lesson, students will be able to define desertification and describe three factors that cause it.

Although there are many strategies for developing effective lesson plans, here are some general guidelines to keep in mind:

- Know the purpose of the lesson and let students know what to expect. Think about what students should be able to do by the end of the lesson before actually writing your behavioral objectives.
- Start with the familiar and move to the more unfamiliar. Tailor your objectives to reflect student interests and needs.
- Decide what approaches and specific activities you will use to accomplish your objectives. For example, how will you motivate your students, what types of activities will you use, how will you summarize the lesson, and so on.

- Take time to prepare materials and arrange for guest speakers, field trips, and other special events to make your teaching more effective.

- Finally, decide how you will assess the effectiveness of the lesson, either formally or informally.

From the start, you need to get input from your students so that they want to learn what you want to teach. One way of doing this is to ask your students at the beginning of the course or unit to think about what they want to learn or expect to learn in your class. Not only will this help your teaching—it will also help give students a sense of ownership in the course or program. This is especially important when you are trying to help students improve thinking skills and creativity. If the content is personally meaningful to your students, you will be better able to hold their interest and teach the thinking skills you have identified as important.

LESSON PLANNING MODELS

Based on research about learning styles, we recommend that teachers develop lesson plans that cater to a variety of learning styles and emphasize discovery learning. One model, outlined in McCarthy's *4MAT System*, includes a 4-step design, beginning with a motivational activity, followed by an activity that conveys information. The next segment includes time for the students to practice using the information and ends with an activity that allows the students to apply what they have learned. Motivation and information are more teacher-directed; practice and application are more student-directed. This four-step model is based on the common sense idea that variety helps stimulate interest on the part of learners and that each of us prefers certain types of instruction to others. Most educators would agree that by keeping learning styles in mind when developing environmental education lesson plans, you can help build a more dynamic and effective teaching program. (See the Appendix for a sample lesson planning worksheet.)

Here's a sample environmental education lesson plan for primary students that focuses on acid rain and follows the 4MAT system:

SAMPLE 1

MOTIVATION: Start with an intro that shows students the connection between energy use and acid rain, such as a cumulative chant like "The House that Jack Built" that ties turning on a light to burning coal and causing acid rain to form (see page 114 for an example that focuses on the water cycle). Then ask the students to form small groups to discuss what they know about acid rain. Have them group their thoughts in ways that can be presented to the rest of the class. After each group presents, discuss the commonalities and lead into the next step of the lesson—a mini-lecture about acid rain and energy.

INFORMATION: Using whatever learning aids are available (flip charts, blackboard, slides, etc.), present a brief lecture about the causes and consequences of acid rain. If possible, hand out information about acid rain that the students can read. Emphasize the connection between individual energy use and acid rain.

Practice: Have students create word webs to review the information they've learned about the relationship of acid rain to jobs, environmental damage, people's attitudes, and so on.

Application: Put up displays in the school and community about what causes acid rain and what individuals can do to help lessen the impacts. Also try to get student editorials published in the school newspaper, if there is one.

All teachers, not just a few, and all courses should strive to develop creative ability.

—Abraham Maslow

Sample 2

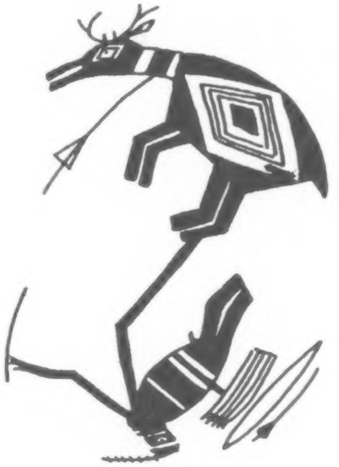
Here's a sample environmental education lesson plan for secondary students that focuses on pesticide safety:

Motivation: Have the students read a moral dilemma dealing with pesticide use and have the class divide into groups to discuss the issues. (See Chapter 7 for an example of a moral dilemma.)

Information: Have a guest speaker describe pesticide use in your community, including information about the health risks and how to safely apply pesticides. Next present information about different kinds of pesticides and why many experts feel that integrated pest management (IPM) can be safer, cheaper, and more effective than traditional chemical pest treatment. Discuss the pros and cons of IPM.

Practice: Have students complete exercises about pesticide use in the country, including health problems associated with applying and disposing of pesticides, benefits of pesticide use, types of pesticides, effect of pesticides on wildlife, and so on. Have students survey community residents about their attitudes and practices.

Application: Have students make public service announcements (radio spots or print) that warn people of the dangers of pesticide use and show them how to apply safer pesticides and get rid of pesticide containers safely.



This 4MAT system also stresses the importance of the experiential learning cycle. According to experiential learning theory, the most effective learning comes from having a concrete experience and then reflecting on that experience, drawing conclusions from the experience and generalizing from it, and finally deciding how to use what was learned to improve, expand, change, and plan for the future. In the four-step model outlined above, the concrete experience usually takes place in the motivation or information steps of the lesson plan.

Experiential or discovery learning forces students to get involved. For example, students may try to clean up an oil spill in a gallon of water using straw, sticks, and matches, take a field trip to a recently deforested area to assess the damage, and establish a mock court, present evidence, and try a case related to environmental terrorism. When students learn by doing, they are often more motivated to learn, retain what they learn longer, and are able to transfer what they know to other situations. Discovery learning also helps students increase self-confidence and self-reliance because they take more of the responsibility for learning.

Instead of telling students information, experiential learning helps them discover for themselves. Environmental education and discovery learning are closely linked. By taking part in hands-on environmental education activities, students are more likely to take a personal interest in the environment and related issues. But as exciting and effective as hands-on learning is, it's important to remember that not all students do well with this type of approach—especially if the learning is too unstructured. For experiential learning to be most effective, it helps to have guided discovery, in which the teacher provides hints and leading questions to keep students on track.

Critical thinking allows students to become active participants in their learning.

—Carol Thanus
Primary school teacher

The experiential learning cycle fits well into the four-step model explained above, but is also the focus of other lesson-planning models. For example, in the "focus-explore-reflect-apply" learning cycle described here, students take part in a concrete experience during the "explore" phase of the lesson:

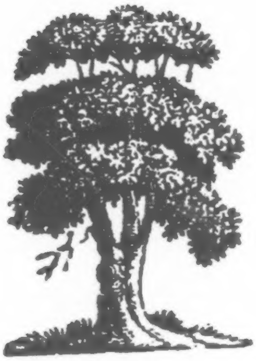
Focus: Explore and clarify the ideas that students already have about the topics.

Explore: Enable students to take part in hands-on explorations of the topics being investigated.

Reflect: Encourage students to discuss their observations and reconcile their ideas.

Apply: Help students to discuss and apply their new ideas in new situations.

(Reprinted from the National Science Resources Center, National Academy of Science and Smithsonian Institution, 1992.)



No matter which lesson-planning model you choose, it's important to recognize the importance of review. Studies have shown that many students learn better when they are reminded of what they're learning (review), why it is important, and how it is related to what they already know or are learning in other classes. For example, if you are about to start the second day of teaching about problems involving coral reefs, you might want to refer back to what happened in the previous lesson first, and then captivate your group with a demonstration, simulation, discussion, or other experience that can engage the students and get them motivated to find out what's coming next.

Lesson planning models, such as the ones outlined above, provide a framework that can remind you to cater to different learning styles and make use of discovery learning. In some cases, a lesson can be completed in one or two class periods. In other cases, a lesson can take longer. See the Appendix for several lesson planning worksheets. (For more about lesson planning, see page 88 in *Teacher Training*, Peace Corps ICE T-45.)

TEACHING TECHNIQUES

One of the most rewarding parts of teaching is fleshing out your lesson plans and developing activities that can help you meet your objectives. Which activities are best? It all depends on you, your students, and your situation. You need to consider the subject, time, materials, student needs, and the balance you want to strike between student-centered and teacher-centered activities.

Some lessons will include many activities; others will focus on one major activity. As with lesson planning, the first step in creating an activity is to consider your objectives. It's also important to think about your approach, the skills you want to emphasize, and the level of instruction, making sure the content matches the level of your audience. (See Chapter 7 for sample environmental education activities.)

The rest of this chapter is devoted to specific topics that can help you develop innovative educational activities that strengthen your environmental education program and your overall teaching. Specifically, we'll focus on identifying student misconceptions, facilitating controversial issues, teaching critical and creative thinking skills, and promoting group cooperation skills.

Remember, many of the activities in the next chapter were developed for a specific audience, culture, geographic location, and so on, and will need to be adapted or completely revised to fit your needs. Also note that each has its own strengths and weaknesses, which you can improve when you adapt and revise.

DO BATS NEST IN PEOPLE'S HAIR?

All students come to class with misconceptions. Some of the things they believe are simply myths or untruths they have picked up from their friends or family, such as bats being able to nest in people's hair or tapirs having the ability to suck out the insides of a dog through their snouts. But other misconceptions are entrenched misunderstandings that provide a skewed understanding about how the world works. Many educators feel that you won't be successful in changing a skewed mental map unless the student does the reworking to put the correct information into a form that fits with his or her previous learning.

One way to better understand student misconceptions is to assess where your students are before starting a lesson. Then you can work with the students to help them examine their previous thinking and reconstruct a more correct explanation. Experiential learning can help students "relearn" and discover for themselves and build correct mental maps. Working with other students who see things differently can also help change perceptions and understandings. There are many ways to assess student knowledge, attitudes, and understandings, from informal questionnaires to formal testing. See Chapter 9 for more about student assessment.

Controversial Issues in the Classroom

Should developed countries sell their hazardous waste to less-developed countries for disposal? Is nuclear power a feasible option for Eastern Europe? Should a wetland area in Sri Lanka be protected as a preserve, limiting the hunting rights of the indigenous people who have hunted there for hundreds of years? One of the best ways to motivate upper elementary, middle, and secondary students and get them to think is to introduce current controversial issues involving the environment into your classroom. Students often jump at the chance to discuss issues that are directly relevant to their lives and interests. At the same time, they can strengthen their critical and creative thinking skills, their moral reasoning skills, their understanding of conflict resolution, and their ability to get along with and respect their peers.

There are many ways to introduce controversial issues into your teaching, from debates to structured controversy resolution. (See Chapter 7 for examples of both.) In many cultures, puppets and role plays are used to introduce controversial issues to students. In all cases, the topic should be challenging, relevant, and appropriate for the intellectual level of the students and the cultural norms of your community. And the procedure you want students to use should be clear to the students at the beginning of the process. In debates, for example, you could have the students take one side of an issue, research it, prepare arguments supporting their views, and try to convince others (the teacher or a student panel) to agree with their position. In structured controversies, students could argue both sides of an issue, then work as teams to come up with a collaborative solution that involves thinking from both sides of the issue and relies on input and consensus from all in the group. At the conclusion, each person writes an essay summarizing what he or she learned from the activity.

Throughout debates, conflict, or discussions, it's important for you, as the facilitator, to remain as neutral as you can and to avoid voicing opinions about the topic or your own religious, political, or philosophical views until after students have had a chance to discuss and debate. (Many students will be swayed by your views and tend to side with you.) But you can encourage thought-provoking discussions by asking questions, guiding cooperative strategies, and focusing on specific aspects of the issues, such as the balance between individual freedoms and the social good, the role of the citizen in the resolution of environmental issues, and the underlying principles of a democratic society. It's also important to make sure your colleagues, administrators, and parents are informed about what you are teaching and how you are teaching it—especially if the topic is extremely controversial in your village or town. Think about ways to increase trust levels between school staff, parents, and the rest of the community and talk over your ideas with colleagues.

David and Roger Johnson, educational researchers at the University of Minnesota, suggest students discuss these rules before participating in a classroom controversy:

- I am critical of ideas, not people.
- I focus on making the best decision possible, not on "winning."
- I encourage everyone to participate and master all the relevant information.
- I listen to everyone's ideas, even if I don't agree.
- I restate (paraphrase) what someone has said if it is not clear.
- I first bring out all the ideas and facts supporting both sides and then try to put them together in a way that makes sense.
- I try to understand both sides of the issue.
- I change my mind when the evidence clearly indicates that I should do so.

What can your students gain from taking part in discussions involving controversial environmental issues? Here are just a few of the benefits:

- improved communication skills
- improved ability to collect and interpret information
- improved ability to detect bias
- improved ability to differentiate between fact and opinion
- ability to respect the views of others
- ability to work cooperatively with peers (see page 91)
- ability to make logical conclusions
- chance to examine their values and beliefs and those of others
- greater understanding of the subject
- ability to make better decisions and come up with more effective solutions
- ability to see different perspectives
- greater commitment to the problem solving process

THINK TANK: STRATEGIES FOR TEACHING THINKING

As we mentioned earlier, environmental education and critical thinking skills go hand in hand. But what are some strategies for teaching critical thinking skills? There are several ways to do it and many different opinions about how to do it most effectively. Some educators say that you need to spend time teaching students about specific thinking skills and helping them examine the thought processes they use. For example, you might spend a class period focusing on how to detect bias or analyze a situation. Many educators also stress that the best way to teach thinking skills is in the context of a content area. That is, if you want students to predict consequences from an action, use a real situation that is teaching content as well as the skill of prediction.

Wonder is the beginning of wisdom.

—Greek Proverb

Environmental education is one of the best ways to help teachers teach thinking skills because students are naturally curious about the natural world and the environmental issues that are directly relevant to their lives and the lives of their families and neighbors.

Once you outline those skills you feel are most important to teach, you can integrate them into everything you do. For example, ask questions that make your students use the thinking skills you've listed (see below for questioning strategies) and encourage them to support their answers. Encourage activities that help students analyze, apply, and evaluate information. For example, play the devil's advocate during discussions and encourage debates. And discuss controversial issues in the classroom that make students look at complex relationships between environmental, economical, social, political, and moral concerns. (See Chapter 7 for activity ideas that stress critical thinking skills and the Bibliography for resources that can help you incorporate thinking skills into your teaching.)

CREATIVITY—GENERATING NEW IDEAS AND APPROACHES

All students have the potential to think creatively. And environmental education activities lend themselves to helping students reach their creative potential in many different subjects—from writing to drama to science. Creativity is an especially critical part of environmental problem solving. By encouraging brainstorming, discussion, discovery learning, and creative questioning, you can help students come up with new ideas, approaches, and ways of looking at a problem. Solutions to environmental issues and conflict often involve unconventional methods, imagination, creative ideas, and innovative approaches.

Creativity in environmental education can mean making a poster about contour plowing using a new technique or coming up with a clever saying encouraging people to conserve energy. It can mean creating a display about how a coral reef benefits the community or writing a play about the consequences of tropical deforestation. And it can also result in a creative solution to a local environmental dilemma.

It's always important to keep culture in mind when thinking about creativity. Researchers have found that in some countries, creativity takes on a variety of meanings. Discussing creativity with colleagues and what role creativity can play would be a good start to determining what is most appropriate in your situation.

THE ART OF QUESTIONING

To produce a world of critical and creative thinkers that can help solve environmental problems, we need to encourage students to ask questions and think critically. To do this, we need to ask them the right kinds of questions and model good questioning techniques. But it's not that easy to ask good questions—questions that are thought-provoking and varied. Although teachers ask a lot of questions (research shows that some teachers ask more than 400 questions a day), most of the questions have only one right answer and require students to pull facts and figures from their brain. Unfortunately, these kinds of questions don't encourage students to explore or think at higher levels. What color is amethyst? Where is Belize? What's the definition of a tropical rain forest?—are all examples of these "what's the right answer" factual questions.

The reliance on a right answer has also led some students to not really think about the question asked at all and instead focus on coming up with an answer. In one study, students were asked questions like this: "There are 26 sheep and 10 goats on a ship. How old is the captain? 76 of the 97 students "solved" the problem by adding, subtracting, multiplying or dividing. They felt they were expected to answer the question as quickly and "correctly" as possible. They did not feel they were expected to make sense of the problem. Instruction and practice had not emphasized understanding the problem.

Although factual questions are important, they should be balanced with more stimulating questions that make students think about something differently, come to a different conclusion, or reflect on something important. There are many different kinds of questions that can help students grow intellectually and creatively. And there are many strategies for using questions in your teaching. For example, one type of questioning strategy, called *Socratic Questioning*, is designed to probe deeply and get students to think. It also helps open up discussion and allow students to express themselves freely without worrying about being wrong. Here are some sample questions about voting that might be part of a Socratic questioning session:

WHAT DOES "VOTE" MEAN?

How do people decide whom to elect? How should they decide? How could people predict how a potential leader is likely to act? If you don't know about issues or the candidates, should you vote?

Is voting important? Why or why not? What are elections supposed to produce? How? What does that require? What does that tell us about voting?

Why are elections considered a good idea? Why is democracy considered good? What does belief in democracy assume about human nature?

How do people become candidates?

Why does the press emphasize how much money candidates have? How does having lots of money help candidates win?

Why do people give money to candidates? Why do companies?

> *Questions, not answers, stimulate the mind.*
>
> —Richard Paul

Adapted from the work of Richard Paul, A.J.A. Brinker, Karen Jensen, and Heidi Kreklav (Foundation for Critical Thinking, Sonoma State University)

Some educators use the terms "convergent" and "divergent" to describe two basic kinds of questions. Convergent questions are focused questions that usually have one right answer; divergent questions are probing questions that are open-ended and can have any number of answers. For example, "What's the largest river in Zaire" is a convergent question. "What is your reaction to the video's assumption that industry is the 'bad guy'?" is an example of divergent question.

You can also use Bloom's taxonomy to ensure that you ask questions that challenge students to think at higher levels. (See the box on page 90 for questioning cues that lead to higher-level questioning.)

QUESTIONING TIPS AND TRICKS

There are many ways to incorporate what the research tells us about questioning into your environmental education teaching. Here are a few tips and tricks to think about as you plan your lessons. (For more about questioning techniques and different types of questions, see "Teacher Training: A Training Manual, ICE T-46, page 107.)

WAIT A SECOND: Wait at least three to five seconds after asking a question before calling on a student to respond. Also wait a few seconds after the student responds. This "double wait time" will give students more time to think, respond, and participate in questions and discussion.

The best way to get a good idea is to get a lot of ideas.

—Linus Pauling
Nobel Prize winner

FACILITATE WITH FOLLOW-UP QUESTIONS: Push students to go beyond their answers with probing questions such as "Why? Do you agree? Can you elaborate? Tell me more. Can you give an example?"

DON'T JUDGE: When a student answers a question, don't harshly evaluate by saying something like "You're wrong, Jerome." Instead, withhold negative judgment, positively acknowledge the response (nod head, ask whether anyone agrees or disagrees, and move the discussion along. As the discussion continues, the correct answer(s) will surface and be reinforced.

SUMMARIZE: Help students listen more carefully by asking questions like "Could you please summarize Robin's point about the connection between jobs and environmental issues?"

SURVEY: Get students involved by surveying the class: "How many people agree with the author's point about global climate change?"

ENCOURAGE INTERACTION: Encourage students to ask each other questions: "Philip, will you please call on someone else to respond?"

PLAY DEVIL'S ADVOCATE: Encourage students to defend their reasoning by offering different points of view.

DON'T RELY ON RAISED HANDS: Call on students randomly instead of favoring just those with raised hands.

ENCOURAGE "THINKING ALOUD": Ask students to think about how they came up with a response: "Describe how you arrived at your answer."

Cue Student Responses: For example, say "There is no one correct answer for this question. I want you to consider alternatives."

Think, Pair, Share: After asking a question, you can allow time for each person to think about the answer, then have students pair up for more discussion. Finally, have students share their thoughts with the entire group.

Teachers open the door, but you must enter yourself.

—Chinese Proverb

Encourage Action : Ask questions that lead to investigation or action, such as "What happens if you add baking soda to the soil?" "How would you describe the texture of the bark?"

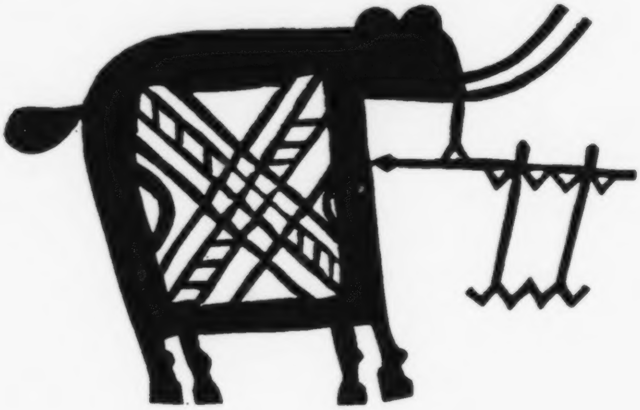
A Questionable Environment: Add questions to displays, bulletin boards, and collections. Start a "Questions to Investigate" corner or a "Problem of the Week" competition.

Don't Answer That: Sometimes the best way to get students to think is to ask rhetorical questions, such as "I wonder what's under that log."

Write Them Down: Many educators think about the questions they want to ask and jot them down before class. This triggers you to remember to ask stimulating questions. The more you practice, the easier it gets to ask questions that make students think.*

* *Adapted from* Critical Thinking Handbook: 4th-6th Grade *by Richard Paul (Foundation for Critical Thinking, 1990)*

These tips were developed for North American and European audiences. It's important to check with colleagues and experts in your country about their thoughts on questioning. You may need to adapt some of these suggestions to fit the needs of your students.



Not to know is bad, but not to wish to know is worse.

—West African Proverb

CUES FOR ENCOURAGING HIGHER LEVEL THINKING

KNOWLEDGE

Who, what, when where, how ______________________________.

Describe ______________________________________.

COMPREHENSION

Retell (in your own words) ____________________________.

APPLICATION

How is ______________ an example of ____________________?

How is ______________ related to _______________________?

Why is ____significant?

ANALYSIS

What are the parts or features of ______________________?

Classify______________ according to ___________________?

Outline/diagram/web _____________________________.

How does ______________ compare/contrast with____________?

What evidence can you list for__________________________?

SYNTHESIS

What would you predict/infer from ______________________?

What ideas can you add to ____________________________?

How would you create/design a new ______________________?

What might happen if you combined ____________ with ____________?

What solutions would you suggest for______________________?

EVALUATION

Do you agree that______________________________________?

What do you think about _____________________________?

What is the most important______________________________?

Prioritize ____________________________________.

How would you decide about ____________________________?

What criteria would you use to assess ______________________?

* *Adapted from "Cueing Thinking in the Classroom: The Promise of Theory-Embedded Tools" by Jay McTighe and Frank T. Lyman, Jr. (April 1988,* Educational Leadership, ASCD)

GETTING YOUR STUDENTS TO WORK TOGETHER

Solutions to most environmental conflicts involve a team problem-solving approach. The team might be made up of a group of citizens, business leaders, politicians, and scientists. It might be students, parents, and school administrators. Or it might be a family decision that involves parents and children. But whatever the mix of talents and expertise, a group brings more to the table than one individual. Many experts feel that the group approach to learning and problem solving (i.e., cooperative learning) is often neglected in classrooms around the world, where the emphasis is more often on competition and individual learning.

If we can't work together, we can't make it work.

—Anonymous

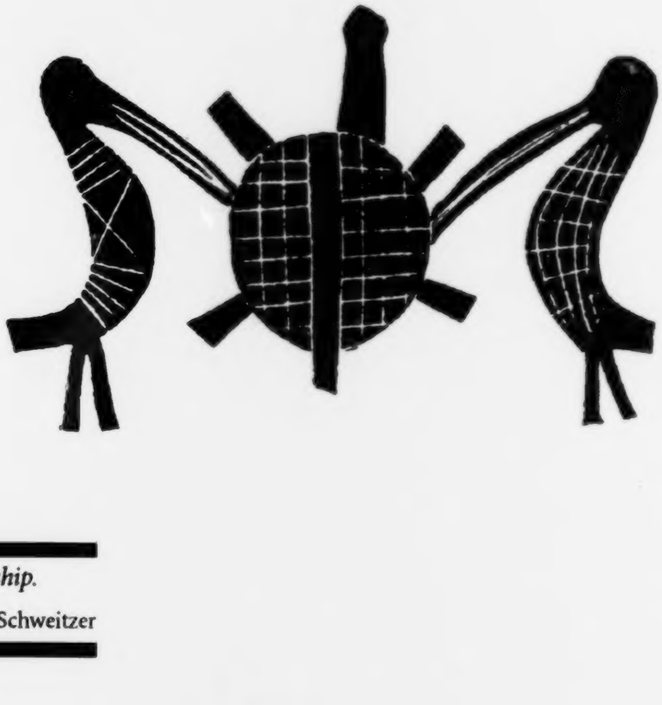
Recent studies have shown that cooperative learning has a lot going for it. For one thing, it can motivate students by helping them realize that they can contribute to the solution of a problem or take part in a creative activity without having to know all the answers or be an expert. In small groups, they learn to think and talk about what they are learning. Cooperative learning can also help promote positive attitudes about the environment and other subjects, improve critical and creative thinking, and help encourage positive self-esteem and respect for peers. Another important benefit of group cooperation is the supportive interactions with fellow students. Instead of ignoring others or doing their best to "beat them," students in cooperative learning groups are more likely to tutor, help, and support their classmates. Research in the U.S. also shows that in mixed groups made up of all types of learners, the lower and middle level students achieve more in cooperative groups than if they were involved in competitive or individual activities. At the same time, high level achievers gain as much through cooperative as through competitive activities.

What exactly is a cooperative learning group? Ideally, it's a heterogeneous group of students working together to achieve a common goal. An important key is that the students are held accountable for the performance of all members of the group—a "we're all in this together" approach. This encourages students to help each other and work together to complete the task. The most effective cooperative learning takes place when all students have a chance to share leadership responsibilities, practice cooperative skills (communicate effectively, manage conflict, and so on), and receive individual feedback. It also helps if students have clearly designated roles for each activity so that they know what's expected of them and the group can hold them accountable.

Although cooperative learning can be extremely effective—especially when dealing with environmental issues and activities, this doesn't mean that cooperative learning should be the exclusive teaching strategy. There are times when competition (the "I win, you lose" strategy) is both fun and appropriate and times when individual learning should be used so that students develop the ability to complete tasks on their own. But overall, many educators use cooperative learning groups as the main teaching strategy and include competition and individual learning within the structure of cooperative teams.

SUMMARY

When developing an environmental education program, you have an opportunity to incorporate all the "excellent education" strategies that research shows really make a difference. From consistently using cooperative learning strategies, effective questioning, discovery learning, and other teaching strategies that have been shown to work, you can help your students build on their strengths, improve their weaknesses, work together, develop thinking skills they will use throughout their lives, and increase self-esteem.



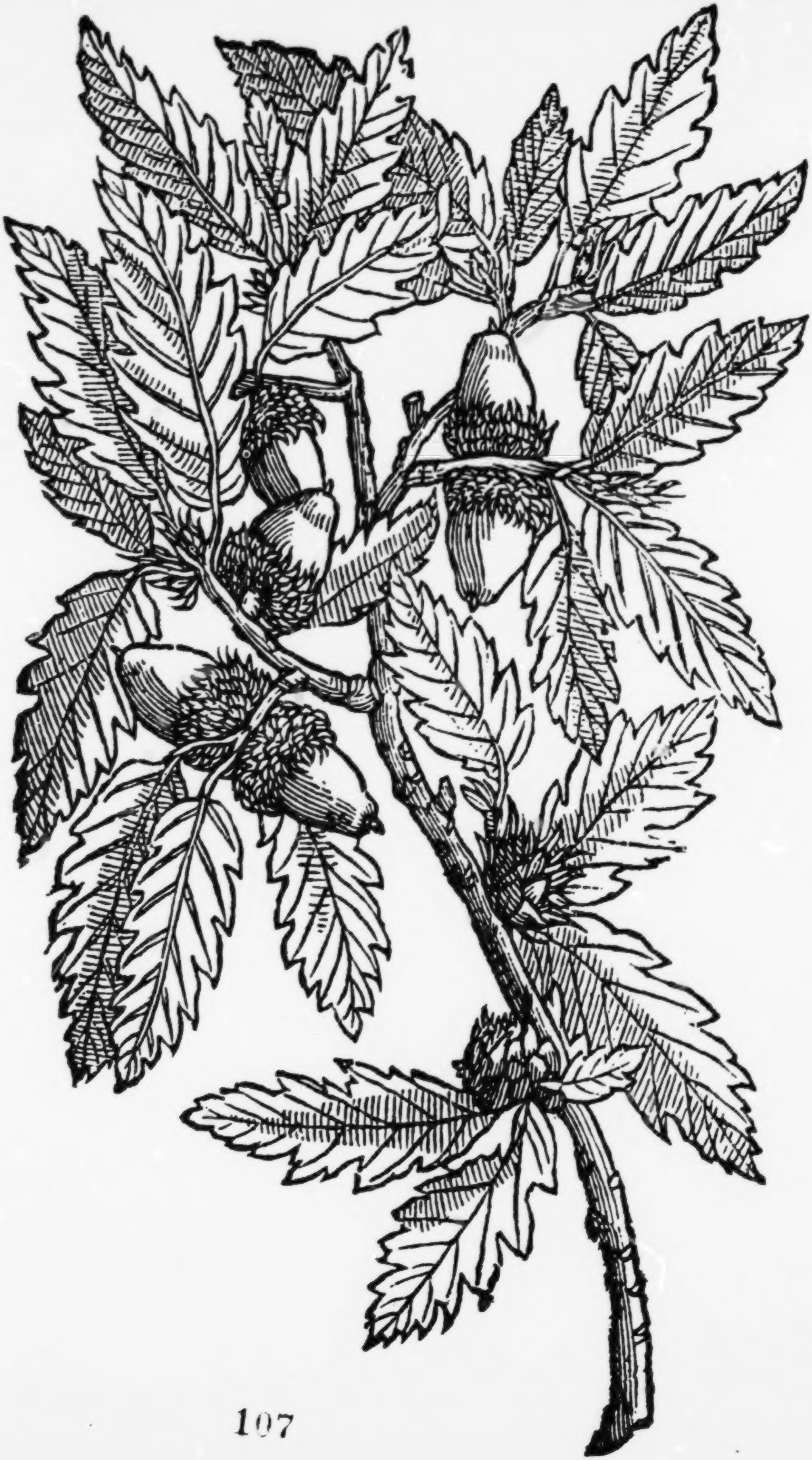
Example is leadership.

—Albert Schweitzer

QUESTIONS TO THINK ABOUT . . .

1. *Have you created lesson plans that cater to a variety of learning styles?*
2. *Have you included activities that motivate students?*
3. *Have you included activities that help students practice and apply what they learn?*
4. *Have you achieved a balance between student-centered and teacher-centered learning?*
5. *Have you included enough hands-on, discovery learning?*
6. *Have you tried to find out what misconceptions your students bring to a topic before teaching new information?*
7. *Have you reviewed the previous lesson and explained objectives for the new lesson?*
8. *Have you introduced controversial issues into your classroom to help students strengthen thinking skills and learn to appreciate other points of view?*
9. *Have you included activities that help students learn to think critically?*
10. *Have you helped students think creatively?*
11. *Have you used innovative questioning?*
12. *Have you used cooperative learning techniques?*

> *We cannot afford . . . to think of the problems of our own society as if we were alone in the world.*
>
> —Peter Berger



7

ACTIVITIES, ACTIVITIES, AND MORE ACTIVITIES

The art of teaching is the art of assisting discovery.

—Mark Van Doren

Putting theories into practice is one of the most creative parts of teaching. By incorporating innovative and educationally sound environmental educational activities, you can develop exciting lesson plans that will motivate your students and equip them with the skills, knowledge, and motivation they need to become active, informed, and committed citizens. In this chapter, we've included a variety of environmental education activities that cater to various learning styles and make use of discovery learning, questioning, critical and creative thinking, problem-solving, values clarification, and other educational practices. Use them as models to develop strategies and techniques that work best in your teaching.

Adapt For Your Audience: The activities we've provided are from a variety of sources. Many of them have been developed with a North American, European, or Australian bias. As you adapt and rewrite to fit your needs and available materials, be sensitive to cultural differences, country-specific needs, and relevance. Many of the activities will not be appropriate at all. Others will be fairly easy to adapt. And we hope that many will spark an idea in your brain to develop something new and creative that fits your needs and gets your students fired up.

Test and Revise: Once you develop an activity, it really helps to test it out with students and teachers from several different schools. Ask your colleagues for suggestions and see if they'd be willing to try it with their students. Use their feedback to improve the activity and add notes that can help other educators use what you develop.

Check Out the Resources: There are dozens of activity sources that can provide you with environmental education activities and give you ideas for creating your own activities. See the Bibliography for an annotated listing.

It's important to first outline your program and lesson plan objectives before developing activities. (See chapters 2, 3, and 4 for more about defining goals and objectives and developing your curriculum outline.) It's also important to create activities that fit the intellectual, emotional, and physical levels of your students.

Check Out Your Activities: After you develop an activity, run it through this checklist to see if it's on target:

- **Motivation:** Does the activity grab the attention of your students?
- **Intended learning outcomes:** What is the objective(s) of the activity? How will you evaluate its success? How will the students apply what they learn?
- **Critical thinking skills:** Have you outlined the thinking skill(s) that will be emphasized during the activity? Are the skills appropriate for your students?
- **Creativity:** Does the activity help your students think creatively? How?
- **Questioning:** Have you outlined the questions you will ask? How many encourage higher level thinking skills?
- **Action:** If you introduce an environmental problem, is there some type of concrete action the students can take to get involved? Is the presentation balanced?
- **Relevance:** Is the topic relevant to the students' lives and interests? Have the students had a say in what they are learning?
- **Context:** How does the activity fit in with your overall teaching plan? How does it fit with what the students are learning in other classes?
- **Subjects:** Is the activity interdisciplinary and does it reinforce a variety of knowledge and skill areas?
- **Materials:** What materials are needed? Are they easy to get and assemble?
- **Stereotypes:** Are there any stereotypes or biases in the materials? Are any groups under-represented? Is the language sexist?

Pick An Approach: To meet your lesson-plan objectives, you need to develop or adapt an activity or a group of activities that help students understand, practice, and apply new information, as well as get them motivated to learn. From demonstrations and experiments to role plays and guided imagery, activities can take many forms. Effective and experienced teachers use a variety of teaching techniques and strategies to accommodate the varied learning styles of their students. When possible, they plan a range of activities that touch on all learning domains: the cognitive (knowledge), affective (feeling), and psychomotor (physical). They also consider the balance between teacher and student-centered activities and try to emphasize cross-curricular goals.

FINDING AND DEVELOPING EDUCATIONAL MATERIALS

We've divided the activity examples in this book into the following general categories. As you will see, this is a mixed list, with some sections focusing on teaching strategies or techniques (such as group cooperation or moral dilemmas) and others on specific content or subject areas (such as urban activities or reading and writing). Although these groupings overlap, each category emphasizes an important aspect of environmental education and includes examples that can help you develop activities that work best for your situation.

> *It really helps to see what others have done. I can take what I like, add what I need, and throw out what doesn't fit.*
>
> —A Volunteer from Belize

1. USING THE SENSES 99
2. MUSIC/RAP/DANCE/DRAMA 105
3. ROLE PLAYS AND OTHER SIMULATIONS 133
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6. CARTOONS, FANTASY, AND CREATIVITY 197
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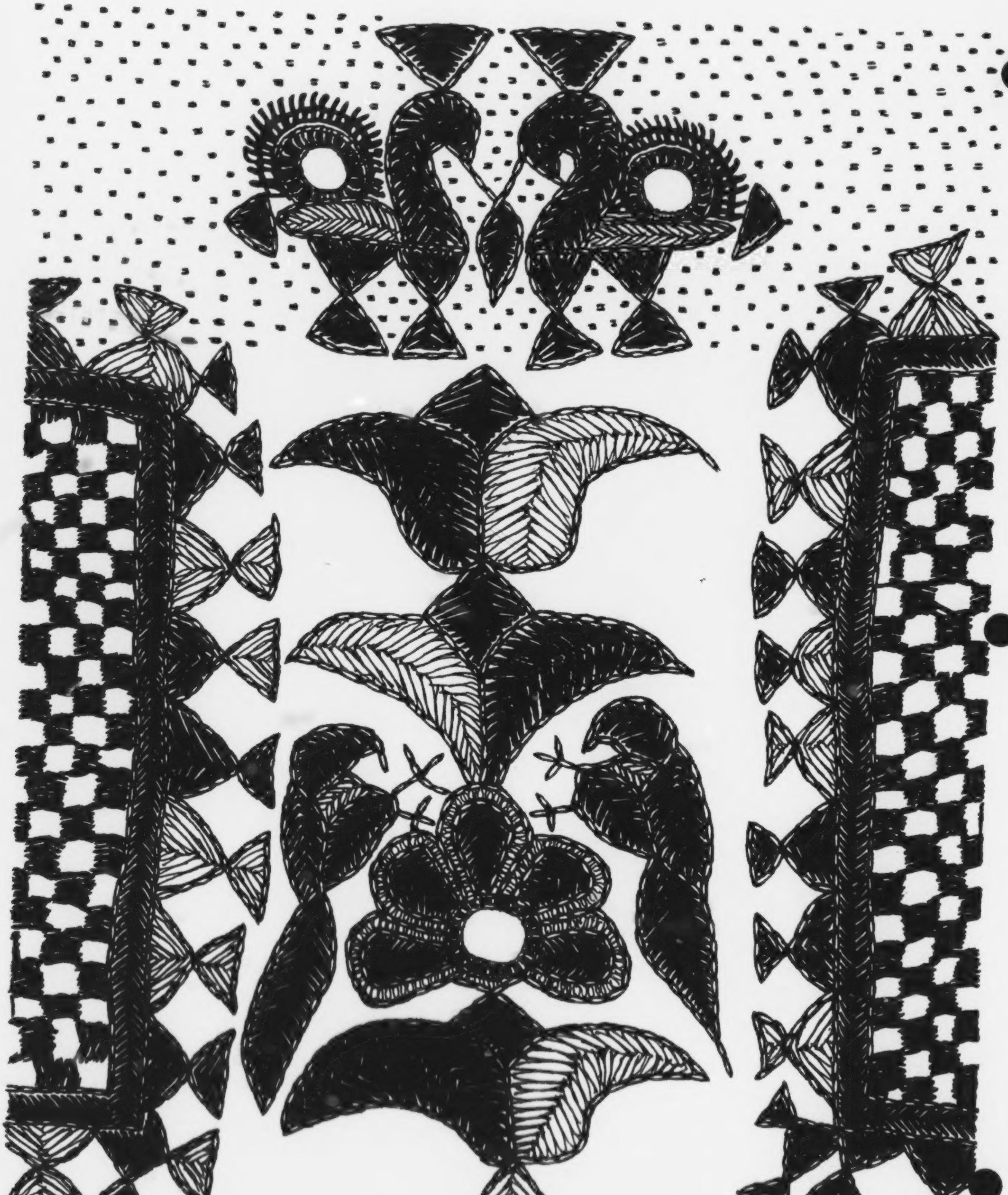

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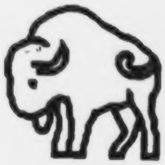
USING THE SENSES

1.

Teach the legal rights of trees, the nobility of hills; respect the beauty of singularity, the value of solitude.

—Josephine Johnson



It's hard not to have a reaction when you hold a handful of squirming earthworms or watch wildebeest thunder across the savanna. Or to smell a stinkhorn fungus. Or eat a ripe berry from the vine. Immersing students in activities that encourage seeing, tasting, touching, hearing, and smelling is an important piece of a holistic environmental education program. Both indoors and out, sensory activities can help students learn about their world first hand and discover information on their own and in their own ways. From wading into a wetland to taking a sensory hike, sensory activities can help promote positive feelings about the environment, provide students with new information, and develop sensitivity to their immediate surroundings. Sensory experiences—especially for younger students—are especially critical in setting the stage for future environmental learning.

We've included two examples of sensory and awareness activities that you can use and adapt to fit your needs. The first activity stresses observation and awareness by encouraging students to "adopt-a-tree." The second helps younger children strengthen their memory and observation skills. You might also want to try the activity "Expanding Sensory Perception" in Section 18, which takes students on a sensory hike through a forest.

ACTIVITIES IN THIS SECTION

1. **ADOPT-A-TREE**, adapted with permission from *Project Learning Tree* published by the American Forest Council and the Western Regional Environmental Education Council.
2. **DUPLICATION**, reprinted from *Sharing Nature With Children* by Joseph Cornell, published by Dawn Publications (1979).

ADOPT-A-TREE

OBJECTIVE:
List the basic characteristics of a tree as determined by observations.

AGES:
Primary, intermediate

SUBJECTS:
Language arts, humanities, science

MATERIALS:
A tree (Optional: a journal, tape recorder, camera)

This activity may be conducted as a class project, with a class divided into groups of three or four students each, or with students working individually. Several related activites are included in this section.

This activity begins with adopting a tree (or trees) near or on your school site. If there are no trees nearby, you might bring a potted tree to your classroom or try to have a tree planted on the school grounds. "Adopting-a-tree" is a valuable way to initiate a unit of study on trees with any age group.

THE FIRST VISIT

- Visit the adopted tree(s).
- Describe the tree as it is right now, today.
- Look at its physical characteristics (size, leaf shape, bark color, and other features).
- Look to see whether it is alive. How can you tell?
- Look to see whther it appears to be asleep (dormant) or awake. How can you tell?
- Listen to find out whether it makes any sounds.
- Smell to find out whether it has an odor. Do different parts of the tree smell different—like bark, old leaves, new leaves? Think about whether the tree and its parts might smell different to you at other times of the year.
- Think about how the tree got where it is and how new trees might come to join it.
- Think about what other living things might need this tree for survival.
- Think about what things the tree might need for its own survival.
- Think about how long the tree might live.

Warning: Do not taste any part of the tree.

Repeat the visits throughout the year and compare observations made each time.

- Look to see how the tree has changed.
- Look to see in what ways the tree has remained the same.
- Think and talk about what the tree might look like the next time you visit it.

AFTER THE FIRST OR MORE VISITS

Once back in the classroom, and now that you and your students have adopted a tree, you might ask your students to tell you what they think a tree is. Accept all statements offered and be careful to record the students' exact words and phrases. List the statements on the chalkboard; discuss and make any changes suggested. When statements have been agreed upon, you and the students can put them together in the form of a poster, chart, or bulletin board.

Here are some sample statements:

A tree is a living thing.

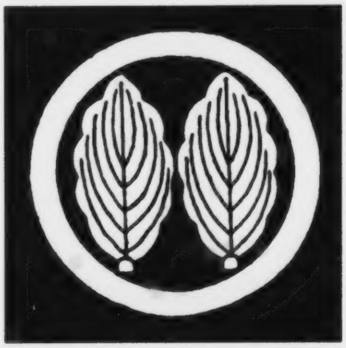
A tree has many parts, just as people have many parts to their bodies.

There are the trunk (main torso), bark (skin), branches (arms, legs), leaves or needles (hair).

Trees have names. (The children mention some names of trees.)

A tree has many uses. (You and the students may wish to list some.)

A tree interacts with and is dependent upon many other organisms, such as insects, mammals, and birds.



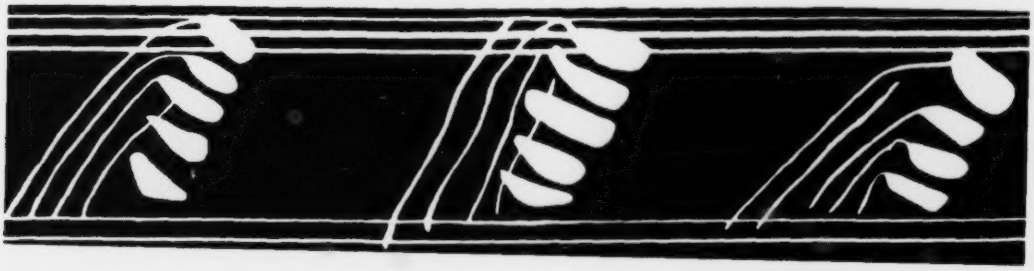
EXTENSIONS

These initial activities can help you decide on follow-up projects by indicating what the students already know, what their interests are, and the kinds of additional information they might acquire.

1. Brainstorm from 10 to 15 adjectives that could be used to describe a tree. These words can be used to write a poem (haiku or cinquain) or short paragraph about the tree.
2. Create and present a short story, puppet show, or play about the tree's parents and/or its offspring.
3. Imagine sounds you might hear near the tree. Can you hear leaves moving, animals, birds? Write a brief description of these sounds, inventing appropriate words, if necessary. Imagine you are looking at the tree. What colors and shapes do you see? Write a brief description, using your new words, of how the tree looks, smells, feels, and sounds.
4. Write a brief imaginary conversation with your tree. What might your tree think, see, feel, hear, and smell? (You may wish to record the conversations on tape.)
5. Imagine you are a radio or television reporter interviewing a person, bird, or other animal that lives in a forest or in a tree. Write down some questions you might ask, such as: How do you like your home? Who are your neighbors? What do you do for a living?

> *If I had influence with the good fairy . . . I should ask that her gift to each child in the world be a sense of wonder so indestructible that it would last throughout life.*
>
> —Rachel Carson

6. Take a tree to lunch. During lunch, consider these and other questions:
   - What is it like under the tree?
   - What animals visit the tree while you are there?
   - What kind of help, if any, is the tree getting from people (watering, feeding, pruning), and does it need that help?
   - Why and when does it need help?
   - What kinds of things, if any, are damaging the tree?
   - Has the tree cast seeds? Have any seeds developed into seedlings?
   - How does the tree take care of itself?
   - How much of its history can you observe? Has it had any accidents (such as being hit by lightning)?
   - Is the tree crowded by other trees or by buildings?
7. See whether your tree makes a shadow. Watch the changes in your tree's shadow at different times of the day and during different times of the year.
8. See whether you can use your tree, without hurting it, to make a sundial. Can it help you keep time?
9. Make paintings, drawings, or photographs of the shapes and shades of color you find when sunlight and shadows can be seen on and around your tree.
10. Describe your tree in enough detail so that someone else can recognize it. Share what you have learned by inviting someone else to visit your tree—and be sure to visit your friend's tree, too.



DUPLICATION

This is a good game for getting children interested in rocks, plants, and animals. Before assembling the children to play, secretly gather from the immediate area about 10 common natural objects, such as rocks, seeds, conifer cones, plant parts, and some signs of animal activity. Lay the objects out on a handkerchief and cover them with another handkerchief. Call the children close around you and tell them, *"Under this cloth are 10 natural objects that you'll be able to find nearby. I will lift the handkerchief for 25 seconds so you can take a good look and try to remember everything you see."*

After looking at the objects, the children spread out and collect identical items, keeping their findings to themselves. After five minutes of searching, call them back. Dramatically pull out the objects from under the handkerchief, one at a time, telling interesting stories about each one. As each object is presented, ask the children if they found one just like it.

Children have a lively curiosity about the kinds of things you show them—rocks, seeds, plants, and so on. When you repeat the game several times, it has a noticeable strengthening effect on the child's concentration and memory.

Note: Make sure you have students return collected items and don't collect living or rare things.

OBJECTIVES:
Increase interest in rocks, plants, and animals. Improve observation skills.

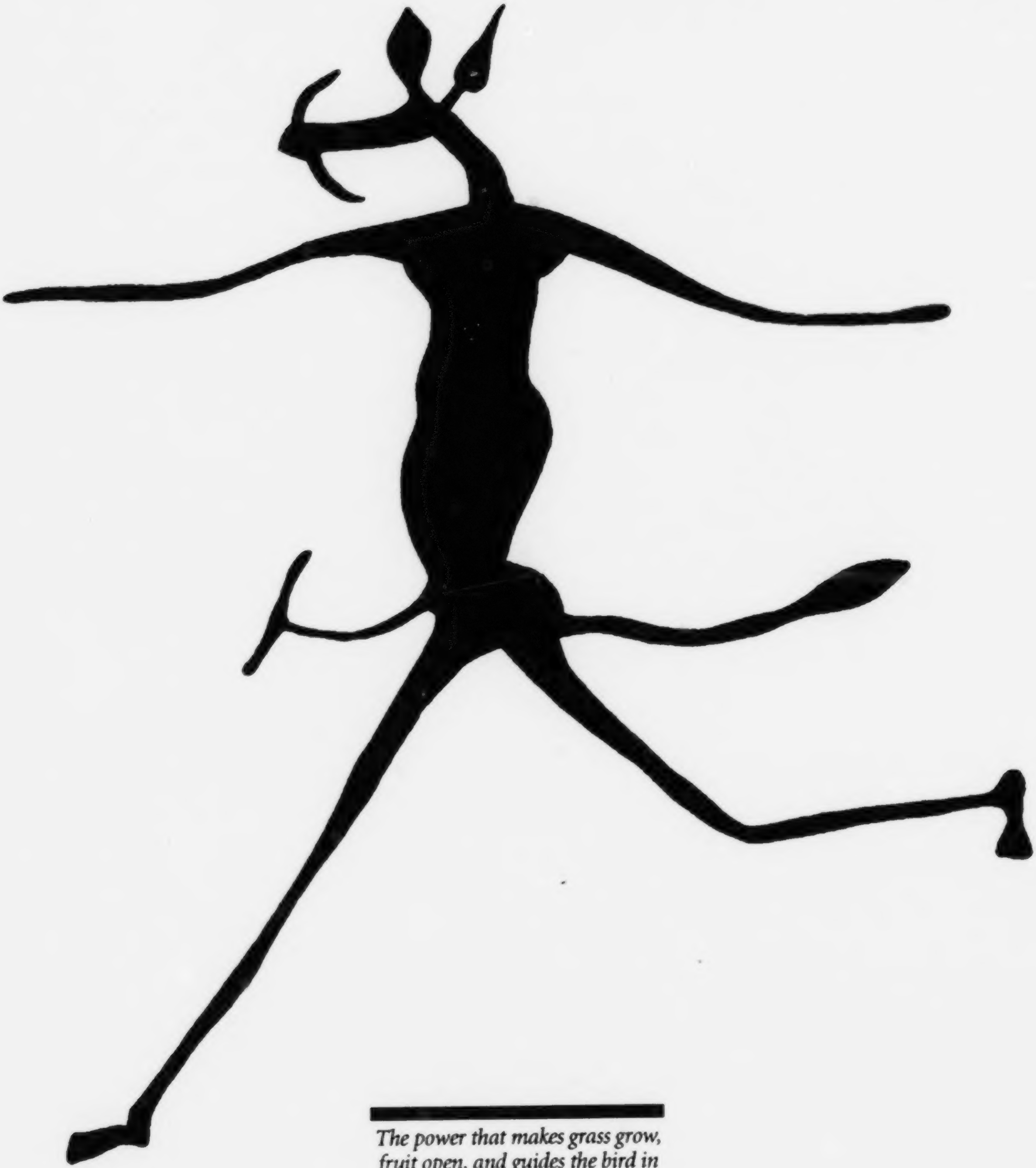
AGES:
Primary

SUBJECT:
Nature

MATERIALS:
2 bandanas

Nature and books belong to the eyes that see them.

—Ralph Waldo Emerson



The power that makes grass grow, fruit open, and guides the bird in flight is in us all.

—Anzia Yezierska

MUSIC/RAP/ DANCE/DRAMA

2.

> *Music appears in every culture as a kind of expression of the most basic values and feelings of people. Thus, whatever it is that music does for people, it somehow involves [our] quest for an understanding of the world and of [ourselves]. On a larger scale, music (along with the other arts) is a vehicle for the expression of what is happening in the culture of the performer, composer, or listener, an expression of things in that culture that cannot be readily verbalized.*
>
> —Bruno Nettl

A puppet show explaining food chains. A rap song about garbage. A role play about pesticides. There are dozens of ways to create effective environmental education activities using creative dramatics, dance, and music. For example, you can create a rap that teaches specific content or focuses on specific behaviors and attitudes. You can have students write a play focusing on how they've been affected by an environmental problem.

In many countries, creative dramatics, dance, music, and songs are used more than written materials to get a message across. This is especially true in cultures where the traditional mode of communication is oral. Talk to experts in-country about the types of activities students are most familiar with and build on traditions and existing ideas.

In the following activities, we've included an example of a garbage rap that describes the history of garbage in 10 stanzas. Students can perform a rap like this for other students, with different groups responsible for one verse and the whole group chiming in on the chorus. Or each group can create its their own rap and perform it for the group. We've also included a revue of music and poetry that focuses on life in the rain forest. Students can perform different sections and/or create their own revue focusing on a habitat in their area. The third activity is a short mini-drama about water that takes off on "The House That Jack Built" and includes a U.S. version and an adapted version that was used in a workshop in Botswana. And finally, we've included two plays: the first was developed by Peace Corps volunteers for the Tikonko Secondary School in Sierra Leone; the second focuses on air pollution problems in the U.S. and some of the "bad guys" that cause the problems.

ACTIVITIES IN THIS SECTION

1. **THE GARBAGE SHUFFLE**, reprinted with permission from *Ranger Rick's NatureScope: Pollution—Problems and Solutions*, published by the National Wildlife Federation (1990).
2. **RAIN FOREST REVUE**, reprinted with permission from *Ranger Rick's NatureScope: Rain Forests—Tropical Treasures*, published by the National Wildlife Federation (1989).
3. **THE ALL NEW WATER REVUE** by Martha Monroe, reprinted with permission from the National Science Teacher's Association (*Science and Children*, January 1990).
4. **TROUBLE IN TIKONKOWO**, written by Gabriel Nabie, Morri Abiubu, and Julia Washburn for the Tikonkowo Secondary School Nature Club in Sierra Leone, West Africa.
5. **THE AWFUL EIGHT**, reprinted with permission from *Ranger Rick's NatureScope: Pollution—Problems and Solutions*, published by the National Wildlife Federation (1990).

GARBAGE SHUFFLE

OBJECTIVES:
Describe how people have disposed of solid waste through history. Describe several problems of solid waste disposal.

AGES:
Primary, intermediate

SUBJECTS:
History, social studies, music

MATERIALS:
Copies of "The Garbage Shuffle" on page 108. (Optional: materials to make costumes and props)

If you were an archaeologist, you could sift through the dusty remains of every human population since prehistoric times and discover something common to all of them: trash. By performing a trash rap, the kids in your group can learn about the history of how people have dealt with trash.

Begin by asking the group how people get rid of their trash (by dumping it, burying it, or burning it). Explain that the task of getting rid of garbage has been around as long as people have existed. Next, pass out copies of "The Garbage Shuffle" and have the kids read through the rap. Then use information under "A History of Trash" to discuss the disposal method common to the time period depicted in each of the verses. Use these questions during your discussion:

- What kinds of trash have people thrown out during different periods? How did they dispose of it?
- Why could prehistoric hunters throw trash on the ground without any problems? How did trash cause problems in ancient Rome, medieval London, and 19th century U.S. cities?
- What kinds of pollution can trash create?
- What are some problems with dumping trash at sea that aren't mentioned in the rap?
- Some people think we should launch our trash into outer space. What do you think about this idea?

Now tell the kids that they can perform the rap. Have a volunteer who can demonstrate the rap rhythm read the first verse out loud so the group can get an idea of how the rap will sound. Then assign each of the verses in the rap to a different child or small group of kids. Everybody can join in for the chorus.

Be sure to give the kids plenty of time to practice their verses. And have them coordinate some moves to accompany the chorus, such as shuffling from side to side and clapping. Encourage them to make up appropriate actions for the verses too, such as pointing their fingers or shaking their heads. You could also have the group make costumes and props to fit the different rap roles. The kids may want to perform the rap for other groups to teach them about how people have disposed of trash through time.

When the kids are ready to perform, have them stand in a semicircle. Start out with everyone doing the chorus, while the first "soloist" or small group moves out in front to do the first verse. At the end of the first verse, repeat the chorus while the first performer(s) returns to the semicircle and the second performer(s) steps up front. Continue alternating the verses with the chorus until the end of the rap.

Afterward you can have the kids create a trash time line, using drawings and short summaries to describe the various periods depicted in the rap. You might also want to have the group make up a new rap verse to describe the kinds of trash people might generate in the future and the ways they might dispose of it.

Activity idea adapted from "The Throwaway Three" written by Fay Bradley and published in A-Way with Waste, *a curriculum guide published by the Washington State Department of Ecology.*

GARBAGE SHUFFLE

Chorus
Do the garbage shuffle; it's an age-old thrill—
'Cause we all make garbage, and we always will!

1: Now I bet you're askin', bet you're dyin' to see
What a hip hippo hunter from prehistory
Does with garbage! (clap) . . . like old tools of stone—
All that garbage! (clap) . . . like those animal bones.
Well, I throw 'em, I toss 'em, I drop 'em at my feet.
Then I move my camp and go hunt more meat.

2: I'm a wise orator, I'm an ancient Greek.
I was born to talk, and I love to speak
About garbage! (clap) . . . it used to fill our roads—
All that garbage! (clap) . . . now we take it in loads
'Bout a mile beyond our city's limit.
Now our homes and streets aren't buried in it.

3: Now you might be askin' why a British maid
From the Middle Ages would be afraid
Of garbage! (clap) . . . out the window we throw
All our garbage! (clap) . . . to the street below.
Well, our city's so crowded that all of that trash is
Making us sick and giving us rashes.

4: I'm a Spanish explorer and here's what I love:
It's a sailing ship that isn't full of
Garbage! (clap) . . . who wants a messy boat?
All that garbage! (clap) . . . it's tough to stay afloat.
So I toss my trash out into the sea,
Where it disappears and never bothers me.

5: It's the 1860s. I'm a germ detector.
I'm a New York City health inspector.
I hate garbage! (clap) . . . the alleys flow with trash—
All that garbage! (clap) . . . the water's full of ash.
Now those garbage fumes—they can make you ill,
So it's time we cleaned up what we spill.

6: In the Roaring Twenties you would be a grump
If you lived, like me, near an open dump.
It's all garbage! (clap) . . . full of bugs and flies—
In the garbage! (clap) . . . the rats are monster size.
The trash is so high that people say
We'll have garbage mountains 'round here someday.

7: Now we're in the Depression, and some folks feel
That incinerators are the way to deal
With garbage! (clap) . . . it all goes up in smoke—
All that garbage! (clap) . . . but I cough and choke
On the cloudy fumes that fill the air.
I just wish that I could move away somewhere.

8: It's the age of plastics; it's the age of ease.
I'm a '60s chemist, and I'm very pleased
With garbage! (clap) . . . plastic cups, paper plates
In the garbage! (clap) . . . disposables are great.
We've got landfills now to store this waste,
What we throw away can just be replaced.

9: There's an oil crisis, and I have to brag,
'Cause I think I've fixed the biggest snag
With garbage! (clap) . . . 'cause the trash can burn—
All that garbage! (clap) . . . can make a turbine turn.
We'll make energy from our piles of trash.
The only problem will be the toxic ash.

10: I'm your average kid, and I have to say
That I've found an awesome, cleaner way
With garbage! (clap) . . . I try to make much less—
All that garbage! (clap) . . . I'm tired of all this mess.
Now I reuse, recycle, make a compost pile—
It's the garbage shuffle, 1990s style!

THE RAIN FOREST REVUE

Putting on a variety show is a great way for kids to learn about tropical rain forests and some of the incredible animals that live in them. To get the kids started, assign a different group of kids to one of the performances printed under "The Rain Forest Revue" on the next page. (See the "Performance Tips" below for ideas on how many kids to assign to each group.) Or let the kids choose which performances they would like to do. And if you're working with older kids, you may want to have them try creating their own songs, poems, or chants to use during the performance. Then have them put on the "The Rain Forest Revue" for other kids and/or their parents.

OBJECTIVES:
Discuss several characteristics of rain forests. Name several rain forest animals.

SUBJECTS:
Science, language arts, music, art.

AGES:
Primary, intermediate

MATERIALS:
Pictures of tropical rain forests and rain forest plants and animals (see activity for suggestions); copies of the narration, poems, chants, and songs on the following pages; art supplies for making props; reference books

PERFORMANCE TIPS

NARRATOR: You might want to split up the narration among several people, with each person being responsible for saying a different block of narrator copy.

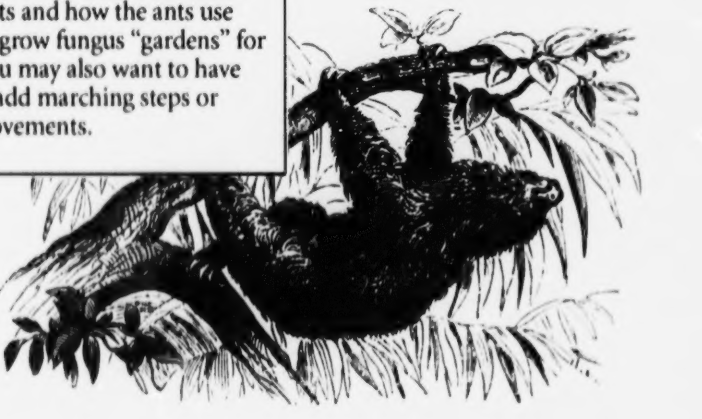
"Jungle Rain" Group: This rhythmic chant works well with two or more kids in charge of saying each verse and performing the corresponding movements.

"World Above the Ground" Group: Four to six kids is a good number of performers for this song. You might want to have two or three kids sing the first two verses and two or three sing the last two, and then have all the kids repeat the first verse. The audience and kids who aren't singing can shout the "echoing" phrases at the end of the first, second, and last lines of each verse.

"Day and Night in the Jungle" Group: Try having three pairs of kids take turns saying two lines of this poem. For example, the first pair could recite the first two lines: "In the daytime, monkeys swing." The next pair could recite "Sloths cling, songbirds sing" and so on until the end of the "daytime verse." Then the first pair could start the "nighttime verse" by reciting the first two lines, followed by the next pair, and so on until the end of the poem.

The "Okapi" and "Blue Bird of Paradise" Groups: Any number of kids can perform these limericks. You might want to suggest that some kids act out the animals while others recite the lines.

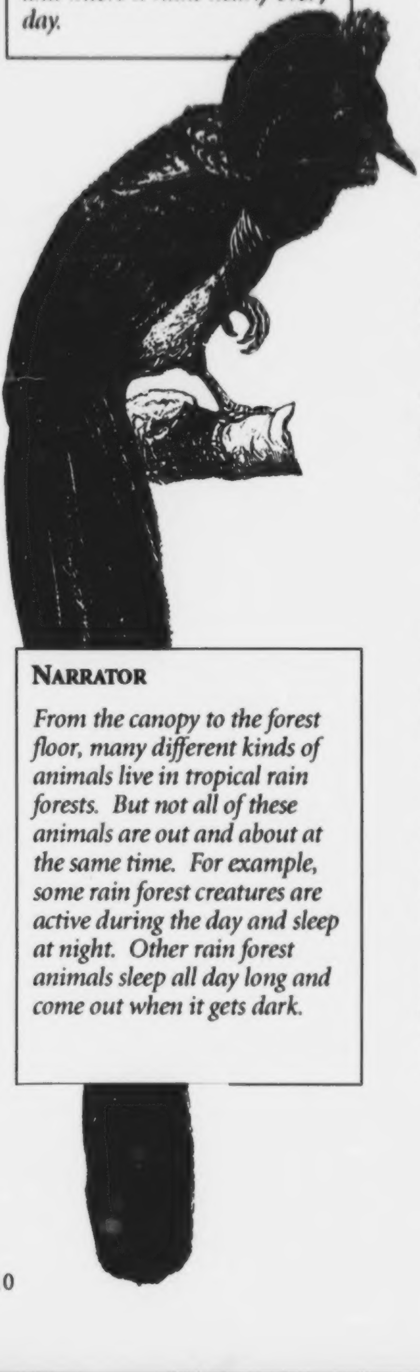
"The Leaf-Cutter Ants' Parade" Group: Either a small or large group can perform this song. But before the kids perform, have one or more of them talk about leaf-cutter ants and how the ants use leaves to grow fungus "gardens" for food. You may also want to have the kids add marching steps or other movements.



THE RAIN FOREST REVUE

NARRATOR

Ladies and gentlemen, welcome to "The Rain Forest Revue." Today we'll be taking you on a journey into the exciting and mysterious world of tropical rain forests—a world where it's warm and green year-round and where it rains nearly every day.



JUNGLE RAIN

Drip, drop, pour and patter
Plip, plop, spit and spatter
Drizzle, drazzle, drain
Jungle rain.

snap fingers in rhythm

Slip, slop, ripple, run
Trickle down, fall upon
Leaf and limb and flower
Jungle shower.

rub hands together in rhythm, getting faster

Crash, smash, lightning flash,
Raindrops splash, creatures dash.
Sticky, steamy, warm
Jungle storm.

pat knees in rhythm, getting even faster

Rivers run, full and flowing
Plants are lush, green and growing.
Clouds begin to fizzle,
Jungle drizzle.

rub hands together in rhythm, getting slower

Sun comes out, shines and gleams
Scattered drops and rising steam
Are all that now remain
Of jungle rain.

all groups say—rhythms slow down and finally stop

NARRATOR

From the canopy to the forest floor, many different kinds of animals live in tropical rain forests. But not all of these animals are out and about at the same time. For example, some rain forest creatures are active during the day and sleep at night. Other rain forest animals sleep all day long and come out when it gets dark.

DAY AND NIGHT IN THE JUNGLE

In the daytime
Monkeys swing
Sloths cling
Songbirds sing.

Orchids bloom
Insects zoom
Parrots chatter
Raindrops patter.

Snakes slide
Lizards glide
And nighttime creatures
Sleep and hide.

In the nighttime
Big cats growl
Owls holler,
Hoot and howl.

Spiders crawl
Night birds call
Insects click
Crickets "crick."

Bats beep
Frogs leap
And daytime creatures
Hide and sleep.

World Above the Ground

(Sing to the tune of "When You're Happy and You Know It")

In the jungle there's a world above
the ground
(*Above the ground!*)—(Say it out
loud!)
In the jungle there's a world above
the ground
(Above the ground!)
Leaves and branches touch the sky
In the canopy so high
In the jungle there's a world above
the ground.
(Above the ground!)

The canopy is plush and lush and
green
(Lush and green!)
The canopy is plush and lush and
green
(Lush and green!)
Nearly 60 feet or more
Up above the jungle floor
The canopy is plush and lush and
green.
(Lush and green!)

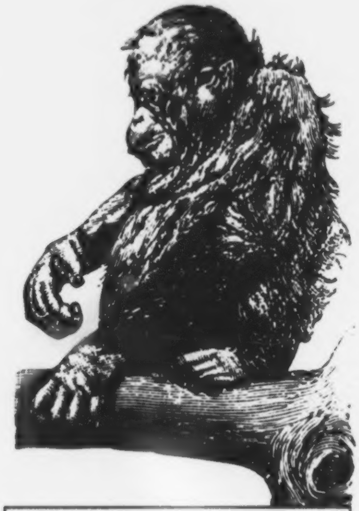
The canopy is home to many
beasts
(Many beasts!)
The canopy is home to many
beasts
(Many beasts!)
Some may never, ever go
To the forest floor below
The canopy is home to many
beasts.
(Many beasts!)

They leap and climb and fly
among the trees
(Among the trees!)
They leap and climb and fly
among the trees
(Among the trees!)
Monkeys, spiders, sloths and slugs
Frogs and snakes and birds and
bugs
They leap and climb and fly
among the trees
(Among the trees!)

All groups repeat the first verse together.

Narrator

All the rain and warmth in the rain forest means that trees and other plants are green and growing year-round. Many of the trees become giants, forming a thick layer of leaves, branches, and flowers high above the forest floor. This leafy forest covering, called the canopy, is loaded with life!



Narrator

Many scientists feel that some of the world's most interesting and beautiful animals live in rain forests. Did you know that rain forests are home to gorillas, toucans, orangutans, and all kinds of cats, bats, birds, insects, and other animals? Some of these species are so amazing it's hard to believe they're real.

The Okapi (oh-KAH-pee)

A strange animal is the okapi
With its stripes and ears big and
floppy.
It seems that whoever
Put it all together
Got tired or maybe just sloppy.

The okapi's a sight, but don't
laugh—
It's a relative of the giraffe.
It eats leaves by the dozen
Just like its tall cousin,
But its neck is shorter by half.

Blue Bird of Paradise

In far away jungles, I've heard
Lives a strange and mysterious bird.
It hangs from a tree
Upside down, so you see—
Its behavior is truly absurd.

This jungle bird puts on a show;
It shimmies and shakes to and fro.
It jostles and jiggles,
It waggles and wiggles,
Its long, silky plumes seem to glow.

You may wonder just why it should be
That a bird acts so strange—
Well, you see,
It hangs from a tree
Because it's a he
And he wants to impress a she.

NARRATOR

Ladies and gentlemen, we hope you've enjoyed our show! And we hope you'll help protect these special habitats so that there will always be rain forests full of marching ants, beautiful birds, incredible okapis, and all kinds of other fascinating creatures. Thanks for coming to our performance.

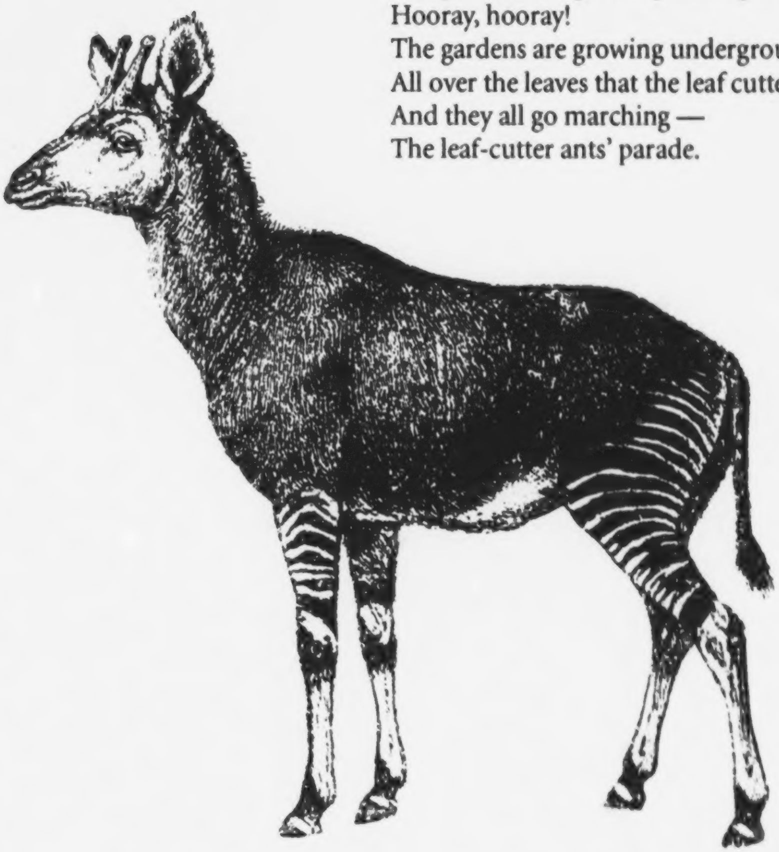
THE LEAF-CUTTER ANTS' PARADE

(Sing to the tune of "When Johnny Comes Marching Home.")

The ants go marching back and forth
Hooray, hooray!
The ants go marching south and north
Hooray, hooray!
The ants go marching east and west
Looking for leaves to take back to their nest
And they all go marching —
The leaf cutter ants' parade..

The ants go marching day and night
Hooray, hooray!
The ants go marching, what a sight
Hooray, hooray!
They munch and they crunch and bite and they tear
Cutting up leaves that they find here and there.
And they all go marching —
The leaf-cutter ants' parade.

The gardens are growing underground
Hooray, hooray!
The gardens are growing underground
Hooray, hooray!
The gardens are growing underground
All over the leaves that the leaf cutters found
And they all go marching —
The leaf-cutter ants' parade.



BRANCHING OUT: TROPICAL ENCORES

Here are two other tropical rain forest performance ideas for intermediate and advanced groups:

YANOMAMO: Named after the largest remaining tribe of indigenous rain forest people in South America, the musical "Yanomamo" focuses on many of the causes and consequences of deforestation. Commissioned by the World Wildlife Fund-UK, "Yanomamo" is a series of songs with accompanying narration. For information on ordering the musical score and cassette tape of "Yanomamo," write to the Customer Service Department of Boosey and Hawkes, Inc., 52 Cooper Square, 10th Floor, New York, NY 10003-7102.

THE TAMARIN TRICKSTER: This play is about the golden lion tamarin, a tiny endangered monkey that lives in the Atlantic coastal forest of Brazil. Originally performed by schoolchildren in Brazil, the play has been translated and adapted for North American audiences. You can find out more about "The Tamarin Trickster" and about tamarin captive breeding efforts by writing to the Office of Education, National Zoo, 3001 Connecticut Ave., NW, Washington, DC 20008.

THE ALL NEW WATER REVUE

OBJECTIVE:
Learn about the water cycle and the role of people in it.

AGES:
Primary, intermediate

SUBJECT:
Science

MATERIALS:
Copies of the skit on pages 117 and 118

"And how did the water get into the pond?" queried the trail guide.

"Rain filled up the pond," chorused the class.

Farther down the trail, she asked, "Where will the water in this stream go if we follow it far enough?"

"To the ocean," they responded.

"Where does our drinking water come from—the water you use for brushing your teeth and washing your hands?"

Silence.

"The underground river?" a brave soul hesitantly replied. Most elementary children have some understanding of the water cycle. They know that rain falls on the mountains and flows through rivers to the ocean, where it evaporates and is blown back to the rain cloud. Rather they know as much as that standard picture tells them. Few students, however, are able to put themselves into the picture. They see tap water appear and disappear, but not, in their minds, as a part of the same cycle.

THIS WATER'S BEEN DRUNK BEFORE

When the children finally learn of the inseparability of the single aquatic system, they wonder in amazement if the water they drink might have been splashed about by a dinosaur. And when they realize that their drinking water might have been drunk before, they squirm in disbelief until someone declares he'll never drink again. Such responses indicate they've misunderstood the very basic notion of cycling water —all water. Although the queasy groans and giggles might be a normal initial response, students should move beyond this reaction toward an understanding of the human part of the water cycle.

To achieve this goal, our standard description of the water cycle should not neglect people and our use of water. Students need that background information to understand the basics of water shortages, water pollution, and water conservation.

A DRAMATIC CYCLE

This skit introduces children to their role in the water cycle. It begins with the action most familiar to children. "I am a person who turns on the faucet and gets a drink." Each child then plays a role proceeding backward through the cycle, from pipes to a pump and a water purification plant (for the city cycle), on to a river or the groundwater, and eventually to rain, clouds, and the sun. At this point, children often believe they are finished and need to be reminded that this does not yet form a cycle. Up to the front of the room come three more students to play the roles of toilet, sewer pipe, and wastewater treatment plant. As each person is added to the line, the chant (see cards, following pages) begins again, reinforcing the cycle.

> *If there is magic on this planet, it is contained in water.*
>
> —Loren Eisley

The skit physically involves students as well; when the classroom is full of a living water cycle, you can form circles of cycling water with different groups of children. The wastewater treatment plant can release water to the river, or evaporate some, with the sun's help, to the clouds.

Communities that have both a municipal water supply and individual wells have the added opportunity to compare both cycles. Groundwater becomes the focal point of a water source for a well and a repository for wastewater from the septic tank.

WHAT'S MY LINE?

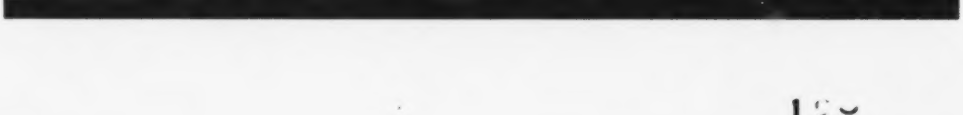
To produce the skit, choose the most appropriate sequence of statements for your area and make a card for each one. Most cards will have two statements, the first to be read only once, when the child enters the cycle. The second statement is read for each turn after that. The statements can be written on one side of the card, with the name of the element (pipe, rain, and so on) written in large letters on the other so the students in the audience can see a cycle forming.

The final sequence in the country cycle, for example, would go as follows:

I am the sun that evaporates the water/that hangs in the cloud/till it falls as rain to the ground where it/recharges the groundwater and moves slowly toward a well/where it is pumped from the ground and/carried through the house/and I turn on the faucet and get a drink!

Adding on the rest of the cycle, the children will continue:

Then the water is flushed down the toilet . . . and carried by sewer pipes . . .



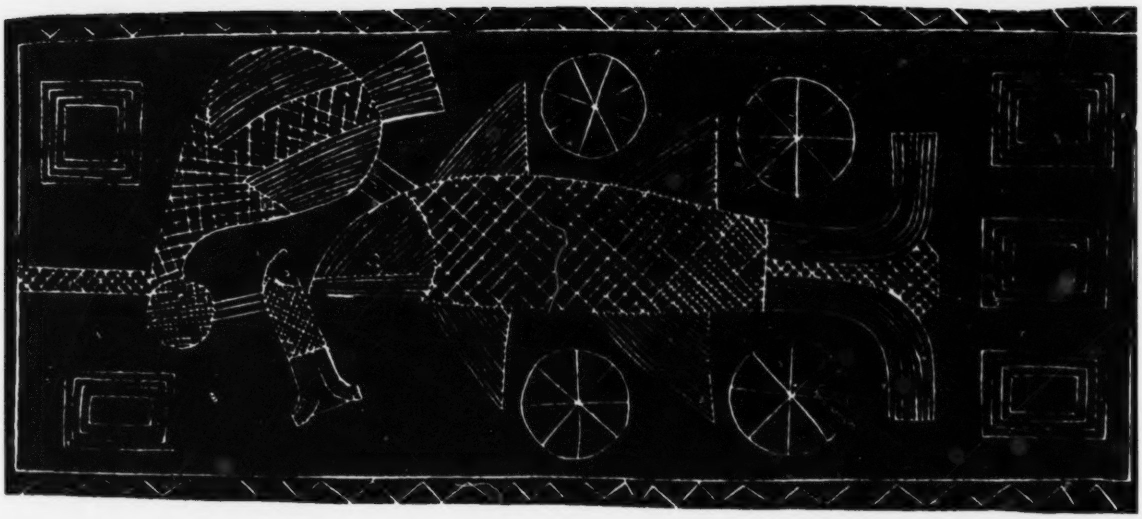
. . . and into a septic tank where micro-organisms decompose many of the waste products and return the water to the ground.

The septic tank person could join hands with the groundwater person to make a physical circle in the room. Ask students to ponder exceptions and deviations from this cycle. What happens when you water houseplants with well water? What if you fill up a small swimming pool? If you pour a toxic chemical down the drain, where does it go? Where in relation to your septic tank should a well be located? When the groundwater becomes polluted, how is it cleaned?

Many of the statements for a typical municipal water cycle are the same as the country cycle. Of course, cards may be added or altered to be more accurate for your own community. Some communities pump drinking water directly from rivers (Ann Arbor, Michigan; Washington D.C.; and Wheeling, West Virginia) or from lakes (Appleton, Wisconsin and Chicago, Illinois) rather than from groundwater. The river and lake cards can be substituted into the cycle and the neighboring cards altered slightly to accommodate them.

And the results? Amid the smiles, giggles, grins, and squeals, students remember their water cycle. The repetitive cadence serves as a drill for the message and lays a foundation for an awareness of our water use. Students begin to see themselves in the water cycle, and that is a healthier place to be than outside of it.

The original skit in on page 117. An adaptation of the skit, developed by teachers in Botswana, is on page 118.



ORIGINAL SKIT

PERSON

1. I am a person who turns on the faucet and gets a drink!
2. . . . and I turn on the faucet and get a drink!

PIPE

1. I am the pipe that carries water through the town into homes . . .
2. where it's carried through the town into homes. . . .

PUMPING STATION

1. I am the pumping station that pumps water into pipes. . . .
2. . . . that is pumped into pipes. . . .

WATER TREATMENT PLANT

1. I am the water treatment plant that purifies the water, adding chlorine to kill bacteria . . .
2. . . . that purifies the water. . . .

RESERVOIR

1. I am the reservoir that holds water for the town until it is pumped into the treatment plant. . . .
2. . . . that holds water for the treatment plant. . . .

RIVER

1. I am the river that flows into the reservoir. . . .
2. . . . that flows to the reservoir. . . .

RAIN (RIVER)

1. I am the rain that falls to the ground and follows the creeks and drains to the river . . .
2. . . . till it falls as rain and into a river. . . .

RAIN (GROUNDWATER)

1. I am the rain that falls to the ground. . . .
2. till it falls as rain. . . .

CLOUD

1. I am a cloud that holds water vapor in the sky. . . .
2. . . . where it hangs in the cloud. . . . .

SUN

1. I am the sun that evaporates the water. . . .

GROUNDWATER (RIVER)

1. I am the groundwater that slowly moves through the soil until I seep into a river . . . .
2. . . . recharges the groundwater and moves slowly to a river. . . .

GROUNDWATER (BOREHOLE)

1. I am the groundwater that slowly moves through the soil until I am pulled up by a borehole. . . .
2. . . . recharges the groundwater and moves slowly to a borehole. . . .

BOREHOLE

1. I am the borehole that pumps water from the ground to the standpipes. . . .
2. . . . that pumps water from the ground to the standpipes. . . .

TOILET

1. Then . . . the water is flushed down the toilet. . . .

SEWER PIPES

1. . . . and carried by sewer pipes. . . .

WASTEWATER TREATMENT PLANT

1. . . . to the wastewater treatment plant where it is filtered, treated, and released to the marshes. . . .

SEPTIC TANK

1. . . . to the septic tank under the house where microorganisms decompose many of the waste products and return the water to the ground.

BOTSWANA ADAPTATION

PERSON

1. I am a person who turns on the faucet and gets a drink!
2. . . . and I turn on the faucet and get a drink!

PIPE

1. I am the pipe that carries water through the town into homes . . .
2. . . . where it's carried through the town into homes. . . .

PUMPING STATION

1. I am the pumping station that pumps water into pipes.. . .
2. . . . that is pumped into pipes. . . .

WATER TREATMENT PLANT

1. I am the water treatment plant that purifies the water, adding chlorine to kill bacteria . . .
2. . . . that purifies the water. . . .

RESERVOIR

1. I am the reservoir that holds water for the town until it is pumped into the treatment plant. . . .
2. . . . that holds water for the treatment plant. . . .

RIVER

1. I am the river that flows into the reservoir. . . .
2. . . . that flows to the reservoir. . . .

TOILET

1. Then . . . the water is flushed down the toilet. . . .

SEWER PIPES

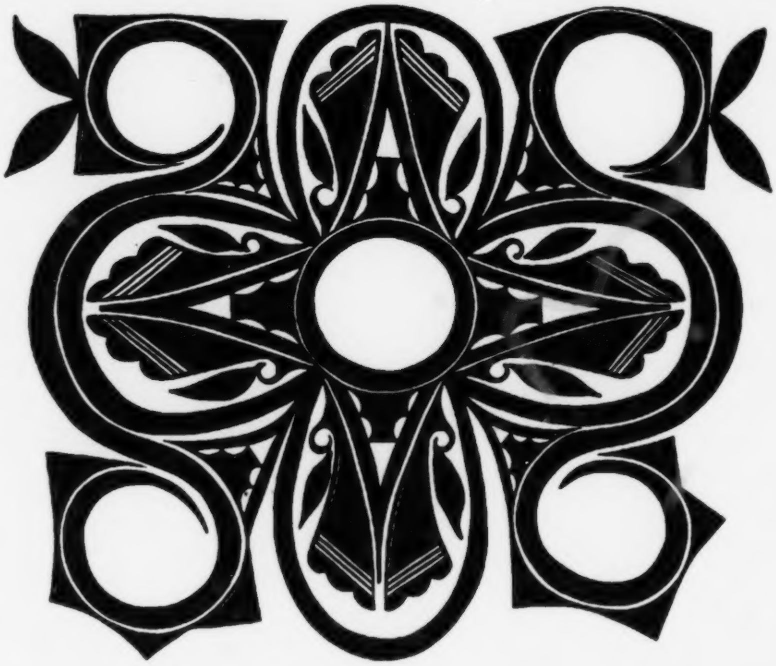
1. . . . and carried by sewer pipes. . . .

WASTEWATER TREATMENT PLANT

1. . . . to the wastewater treatment plant where it is filtered, treated, and released to the marshes. . . .

SEPTIC TANK

1. . . . to the septic tank under the house where micro-organisms decompose many of the waste products and return the water to the ground.



A Conservation Drama

TROUBLE IN TIKONKOWO

SCENE ONE

(All trees should be wearing their names printed on signs.)

Old Pa Cotton: Oh, the things I've seen standing here all these years. I am a very old cotton tree. The young seedlings call me Old Pa Cotton. I've seen a lot over the years. Too much! In fact, it's all very sad. All this land used to be a big forest. Many of my brother and sister trees stood here with me around this little village called Tikonkowo. We were so many back then. Of course, the village was much smaller. As I've stood here, I've watched the village get bigger and the forest get smaller. And it is still happening. But there are a few of my tree friends left.

(Enter Mr. Palm Tree)

Mr. Palm Tree: *(very bluff)* I'm Mr. Palm Tree. I just want to tell you about some of my uses. I am VERY IMPORTANT. In fact, you really need me. I'll make your life nice and easy. As you know, I can make you stout and make your sauce sweet with palm oil. I can also make you feel fine when you drink palm wine. Without me, you wouldn't have baffas or hammocks. I make it easy for you to relax and enjoy. Right now I want you to meet my sister, Miss Mango.

(Enter Miss Mango)

Miss Mango: *(very vain, pushy).* Hey, I'm Miss Mango. My fruit is very sweet to eat. And when the sun is strong, you've got it made in the shade if you sit under me. My wide branches will protect you from the sun. You can even use my leaves for medicine and my limbs for firewood. Come on, Mr. Palm Tree. Let's go.

(Exit Mr. Palm Tree and Miss Mango. Enter Mr. Pawpaw—running, out of breath and suspicious.)

Mr. Pawpaw: *(the tree thief)* Let me tell you quickly who I am. I am Mr. Pawpaw. I don't have too much time because the tree police are chasing me. You see, I like to tell lies to my friends and steal their roots. But I won't lie to you now. People like me because I grow quickly and my fruit is large and sweeter than any other fruit. You can also use my leaves for medicine, and small children like to use my stems to make toys. Well, I've got to run. . . . bye-bye.

(Exit Mr. Pawpaw, running. Enter Miss Gbelui. Enter three Tree Police.)

Tree Police: *(Run in chasing Pawpaw)*

#1: Where did the Pawpaw go?

#2: We have to catch him and put him in the cell.

CAST OF CHARACTERS:

Old Pa Cotton
Miss Mango
Mr. Pawpaw
Tree Police (#1, #2, #3)
Miss Gbelui
Mr. Kola
Mr. Kandji
Miss Tijui
Mr. Leguminous Tree
Villagers:
Bewa (farmer)
Kayma (Bewa's wife)
Ngegba Botu (hunter)
Adama (Ngegba's wife)
Joe Vamboi (Ngegba's son)

Miss Gbelui: Mr. Pawpaw was just here, but he has gone. He's probably off telling more lies somewhere.

Tree Police #3: OK, let's go after him.

(Exit Tree Police, running.)

Miss Gbelui: You can be certain I would never tell tree lies or steal roots. I help people. If you boil my bark, I can make medicine that cures yellow fever. You can also use my bark to dye cloth and raffia. It makes a beautiful yellow color.

(Enter Mr. Kola, Mr. Kandi, Miss Tijui, and Mr. Leguminous Tree.)

Mr. Kola: Ah, Miss Gbelui, people need you, but they need me too. I keep them awake when they don't want to sleep and make them feel fine. In fact, people give away my fruit and call it the gift of life. I'm the kola.

Mr. Kandi: You think you're so important, Mr. Kola. Well, people need me more. They use me to build houses, kitchens, latrines, and schools. That's more important than staying awake. Without Kandi, people wouldn't have any place to live.

Miss Tijui: Well, people need me for cooking their food. I'm an important source of fire wood. I think cooking food is the most important job of all. Miss Tijui is the best.

Mr. Leguminous Tree: What about me? My roots can put important nutrients back into the soil. I can help make soil fertile again so people can grow more food. You have to grow food before you can eat it. I think I, Mr. Leguminous Tree, am the most important tree of all.

(Enter all trees arguing.)

Mr. Palm Tree: Hey you, Legume, I'm more important than you.

Mr. Leguminous Tree: That is a lie. I'm more important than you.

Miss Mango: You are all talking nonsense. I'm the sweetest.

Mr. Pawpaw: Ha ha. You are not the sweetest. My fruit is sweeter than all the other fruits.

Miss Mango: You are wrong, Mr. Pawpaw. You are just a thief. Very soon the Tree Police will be chasing you.

All Trees: Tief-man! Tief-man! *(Make noise.)*

(Enter the Tree Police. Exit Mr. Pawpaw. ALL TREES continue to argue about who is the most important.)

Old Pa Cotton: *(Pa Cotton has remained silent on stage the entire time, observing.)* STOP! Stop this noise. *(Trees reluctantly stop arguing.)* You are all important. People need you all equally, just as they need me. I give them shade and cotton to make clothes and blankets to keep warm. People also use my trunk to make canoes. Remember, a forest is a place where lots of different and important trees grow. People really need all the trees in the forest and all the other plants and animals that live there. Tell me, friends, what other things do people get from the forest besides products of trees?

Miss Gbelui: Different types of animals, like deer, monkeys, leopards, squirrels, and birds live in the forest. They say that the chimpanzee is smarter than all the other animals, so he is the chief of the forest animals, just like Old Pa Cotton is the chief of all the trees.

Mr. Kandi: But why are all these animals important?

Miss Gbelui: The animals are all important sources of food for people.

Mr. Kola: Before people started doing agriculture, they got their rice from the forest. Lots of other plants also come from the forest like ginger, ferns, bamboo, and yams. Many native and English medicines are made from plants in the forest.

Old Pa Cotton: So you see, you are all important and so are the other animals and plants that live in the forest. People all over the world need forests for food, shelter, medicine, and other things. The people who live in Tikonkowo need you all, too.

(Exit all except Old Pa Cotton.)

SCENE TWO

Old Pa Cotton: I have stood here for many years and seen many things. I have watched Tikonkowo grow from a tiny village into a large town. I have watched people being born and families growing, houses being built, and farms being planted. And as I've watched Tikonkowo grow, I've also watched the forest disappear. My brother and sister trees were much more plentiful when Tikonkowo was a small village. If this business continues and people need to cut more trees, it won't matter which tree is most important because there won't be any of us still standing.

(Enter all the villagers wearing signs bearing their names and occupations —villagers silently go about their business beating rice, etc., while Pa Cotton watches.)

Bewa (Farmer): Please allow me to introduce myself. I am Bewa, a native farmer from Tikonkowo. I have 13 children, so I need to cultivate a lot of land. This is Kayma, my wife.

Kayma: (To audience) Awana. *(To Bewa)* Bewa, get to work. My children are hungry. Go and clear some land for a very big farm.

Bewa: Yes, my wife. This year I'm going to cut twice as much land as last year. (Bewa takes a cutlass, goes to the back of the stage, and pretends to cut trees.)

Ngegba Botu: *(To audience)* Awana. I am Ngegba Botu, the fearless hunter, and this is my son, Joe Vamboi. Joe is learning to be a hunter himself. He is the eldest of my six children. Ah, here is my wife now.

(Adama, Ngegba's wife approaches.)

Adama: Ngegba Botu, we need meat. Go to the bush and shoot a monkey.

Ngegba Botu: Joe and I are just about to go hunting, my dear.

Joe Vamboi: Father, if we shoot many monkeys, we can sell them and make lots of money.

Ngegba Botu: Good idea, son. Let's shoot ten monkeys today instead of only one. *(Father and son take guns and go to the back of the stage where they pretend to hunt. Meanwhile, the villagers continue their business. Some people build houses; some do agriculture; some cook.)*

Old Pa Cotton: *(shouting loudly)* FREEZE!!!

Miss Tijui: Pa Cotton, can't you do something to help these people and stop them from destroying the forest and all the good things that are found in the forest?

Mr. Kandi: Miss Tijui is right. If we don't do something, soon there won't be any trees left.

(All trees shout their agreement and beg Pa Cotton to do something.)

Pa Cotton: All right, I will call a meeting of all the Tikonkowo citizens, and we can show them what will happen if they don't change their ways. Tikonkowo citizens gather around and listen to the wisdom of the trees. *(Villagers come back to life and gather around the trees. Some sit down to watch and listen.)* Over the years we trees have watched you people and we have noticed some very dangerous things happening.

(Trees nod in agreement.)

Mr. Kola: For example, Bewa and the other farmers have cut down most of the forest and used up most of the farmland around Tikonkowo.

Miss Gbelui: Yes, and Ngegba Botu and the other hunters have shot almost all of the monkeys and other animals and sold them.

Miss Mango: If you cut down all of us trees, we won't be able to make seeds to reproduce ourselves. Then you will lose all the important foods and medicines you get from trees. Also the animals who live in the forest will die or be forced to leave Tikonkowo.

Mr. Palm Tree: If you kill all the animals and sell them, there won't be any left to eat either.

Mr. Pawpaw: When all the trees and animals are dead, terrible things will happen.

Old Pa Cotton: Yes, for once Mr. Pawpaw is not lying. If all the trees and animals disappear and all the fertile farmland is used up, there won't be any rice, vegetables, or meat for people to eat. All the important products you get from trees like fruit, medicine, lumber, and firewood will be scarce.

Mr. Kandi: Exactly. Also, with no trees there will be no shade from the sun. During the dry season, the land will become very dry. Then during the rainy season, the water will wash away the soil because there will be no tree or plant roots to hold it in place. The soil will run off the land and fill up the river, killing the fish and spoiling the drinking water.

Miss Tijui: With no clean drinking water, food, or wood, people cannot live. So if you cut down all the trees and shoot all the animals, Tikonkowo will be in a lot of trouble.

Bewa: But I don't have a choice. I have to make farms to feed my children, and that means I have to cut down trees.

Ngegba Botu: And I need to provide meat for my family and get money to pay my children's school fees. How can we live without cutting trees and killing animals?

(Villagers look worried and nod in agreement.)

Mr. Leguminous Tree: We're not asking you to stop farming or hunting, but you do need to conserve your natural resources. The trees and animals are natural resources. They are good and useful things that are found in the environment. Human beings cannot make natural resources. To conserve means to use SOME, but SAVE SOME. If you save some trees and animals, they can reproduce themselves and you can use them later or save them for your children to use.

Miss Gbelui: Only shoot the animals you need to eat. Find other ways to make money or raise special animals like rabbits to sell. Only clear the land you need to use. Don't burn large areas that you are not going to cultivate.

Mr. Palm Tree: And when you cut trees down make sure to plant some new seedlings to take their place.

Mr. Leguminous Tree: If you plant me on your farms, I can help put the good nutrients back in the soil that other plants take from it. I can help you use your land longer, and help you produce more food. Also, if you make swamp farms you don't have to cut trees down at all.

Old Pa Cotton: Don't let trouble come to Tikonkowo. CONSERVE YOUR NATURAL RESOURCES!! Use some, save some, and put some back so there will always be plenty for everyone.

Bewa: Thank you for your good advice. We will be sure to conserve our natural resources, the trees, and animals, so trouble will not come to Tikonkowo.

(Villagers shout hurray for the trees, clap, and make merriment. Enter Tree Police, running.)

Tree Police (all): There he is! Grab him!

(Exit Mr. Pawpaw, running and shouting.)

THE END

THE AWFUL EIGHT

Your group can learn about some of the major air pollutants by putting on a play called "The Awful Eight." And by performing the play, they can help teach other people about the pollution problems in our atmosphere.

Before you put on the play, discuss the major air pollutants and the problems they cause. Then assign each part under the "Cast of Characters" below and pass out copies of the play. (You can adjust the number of characters to fit the size of your group.) Give the kids time to learn their lines, design costumes, and plan any special effects they might want to add.

After the kids perform the play, review the eight major air pollutants by having each "pollutant" (or group) come out and take a bow. The pollutants should state their name; what causes them; how they affect people, wildlife, and the environment; and what people can do to help reduce this type of pollution. Or you can have the audience supply this information to see how much they learned from watching "The Awful Eight."

OBJECTIVES:
Name some of the major air pollutants. Describe what produces them. Discuss some of the effects they have on people and the environment.

AGES:
Intermediate, advanced

SUBJECTS:
Science, drama

MATERIALS:
Copies of the play on the following pages; large pieces of posterboard; yardsticks; markers. (Optional: materials for making costumes and props)

CAST OF CHARACTERS:

The number of characters and some suggestions for props and costumes are in parentheses.

Connie Lung, reporter (props—microphone, notebook)

The Particulates (3; props—dirt; costumes—dirty jeans and brown t-shirts, smear dirt on face)

Carbon Monoxide (1; costume—sneakers, hat, trenchcoat, and sunglasses)

The Toxics (5; props—gasoline cans made from cardboard, skull-and-crossbones symbols worn around neck; costume - black clothing)

Sulfur Dioxide (1; prop—water gun or spray bottle filled with water; costume—torn t-shirt, yellow and white streamers attached to clothing)

Nitrogen Oxides *(Nitros)* (5; props—dead branches; costume—each "Nitro" can wear one of the letters in "Nitro")

Bad Ozone (1; costume—sunglasses, sophisticated clothing for a "big city" look)

Good Ozone (1; costume—sunglasses and light-colored clothing with bits of cotton attached to represent clouds)

Chlorofluorocarbons *(CFCs)* (4; prop—plastic foam packing "peanuts"; costume—foam fast-food containers and foam cups or "peanuts" attached to clothing)

EPA Scientists (2; prop—notebook)

Carbon Dioxide (2; costume—t-shirts and shorts, black costume makeup wiped on clothing, legs, and faces)

(This play is adapted from "The Big, Bad Six" by Carolyn Duckworth, Ranger Rick, *September 1987, pp. 22-29.)*

PERFORMANCE TIPS

Have the pollutants make picket signs by taping large pieces of posterboard to yardsticks and writing slogans on the posterboards. (See slogan suggestions in the description of the play's setting.)

If your space is limited, have only some of the pollutants picket at a time.

If some kids prefer nonspeaking roles, you can let them carry picket signs or be camera people filming the report. They could also take on the responsibilities of stage manager, costume designer, or set designer.

Go over these pronunciations with the kids playing the Toxics: benzene (BEN-zeen), xylene (ZI-leen), toluene (TOL-you-een).

If your audience is small, have Harry and Connie come up with ways that people can help reduce air pollution at the end of the play.

SETTING: *In front of the Environmental Protection Agency (EPA) building. The air pollutants are picketing the EPA. Some carry picket signs with phrases such as "Dirty Air—Let's Keep It That Way," "Down with the Clean Air Act," and so on. TV reporters Connie Lung and Harry Wheezer are at center stage. In turn, each pollutant comes forward to be interviewed, while the other pollutants continue to picket in the background.*

Connie: (coughs) Hi! I'm Connie Lung.

Harry: And I'm Harry Wheezer. We're here at the Environmental Protection Agency to cover a late-breaking story. Eight of the world's worst air pollutants are picketing the EPA to protest clean air legislation.

Connie: In tonight's special report, we'll give you the scoop on where these pollutants come from and the ways they can hurt people and other living things.

Harry: Our first interview is with the Particulates.

(Particulates walk over, carrying signs and chanting.)

Particulates: Dust, soot, and grime. Pollution's not a crime. Soot, grime, and dust, the EPA's unjust!

Connie: (coughs) So — you're the Particulates.

Particulate 1: (Soot) Yeah — I'm Soot, this is Grime, and this is Dust.

Harry: You guys are those tiny bits of pollution that make the air look really dirty?

Grime: Yeah! Some of us are stirred up in construction, mining, and farming. (*throws some dirt in the air*)

Soot: But most of us get into the air when stuff is burned—like gasoline in cars and trucks, or coal in a power plant, and even wood in a wood-burning stove!

Dust: And we just love to get into your eyes and make them itch, and make your throat hurt, and —

Grime: (interrupts) Come on, Dust, quit bragging! We gotta get back to the picket line.

(Particulates return to the picket line. Carbon Monoxide sneaks up behind Harry.)

Harry: Let's introduce the folks at home to our next pollutant, Carbon Monoxide. Hey, where did he go? Oh, there you are! Pretty sneaky, Carbon Monoxide!

Carbon Monoxide: Yeah, sneaking up on people is what I do best. I get into the air when cars and trucks burn fuel — but you can't see or smell me.

Connie: Then how can we tell when you're around?

Carbon Monoxide: You'll find out when you breathe me in! I can give you a bad headache and make you really tired. (Gives an evil laugh.)

Harry: *(yawns)* Oh — I see what you mean. Thanks for talking with us, Monoxide. (yawns again)

(Carbon Monoxide returns to picket line.)

Connie: *(checking notes)* Next we'd like you to meet some of the most dangerous pollutants — the Toxics.

(Toxics walk over, carrying signs and chanting.)

Toxics:
Benzene, xylene, toluene
You'll find us in your gasoline.
Don't worry, we won't make you sneeze;
Instead we'll give you lung disease.

Asbestos, mercury, even lead,
Just breathe us and you may be dead.
Poison's what we're all about
So you better stay clear; you better watch out.

Harry: You Toxics are made up of all kinds of poisons. How do you get into the air?

Toxic 1: Hey, man, we come from just about everywhere. Chemical plants, dry cleaners, oil refineries, hazardous waste sites, paint factories . . .

Toxic 2: Yeah, and cars and trucks dump a lot of us into the air too. You probably don't know it, but gasoline is loaded with us toxics.

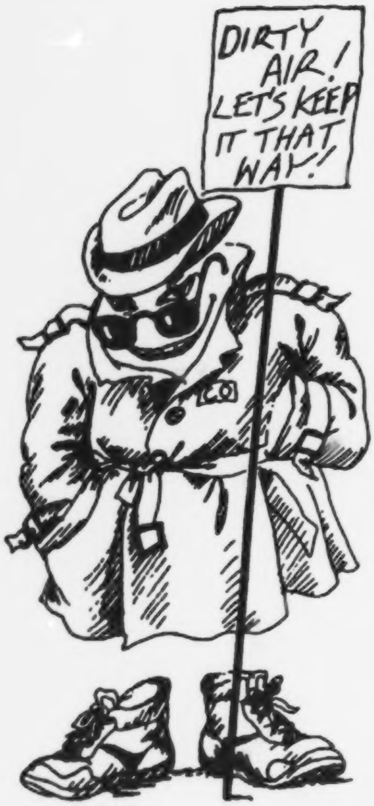
Toxic 3: Wow, that's for sure. There's benzene, toluene — all kinds of great stuff in gas.

Connie: Scientists say you cause cancer and other kinds of diseases. What do you think of that?

Toxic 4: They can't prove a thing!

Toxic 5: That's why we're here — to make sure you people don't pass any more laws that might keep us out of the air. C'mon, Toxics — we're outta here.

(Toxics return to picket line. Sulfur Dioxide walks over.)


DIRTY AIR! LET'S KEEP IT THAT WAY!
CO

The average car gives off its own weight in carbon dioxide every year.

Connie: Next we'd like you to meet Sulfur Dioxide. *(turns to face Sulfur Dioxide)* I understand you just blew in from the Midwest.

Sulfur: Hey, I wouldn't miss this for all the pollution in New York City!

Harry: I'm sure all the folks at home would like to know how you get into our air.

Sulfur: Well, heck, don't they read the newspapers? I've been making the front page at least once a week! Most of the time, I shoot out of smokestacks when power plants burn coal to make electricity.

Connie: And what kinds of nasty things do you do?

Sulfur: Nasty — that's me! *(snickers)* I think it's cool to make it hard for some people to breathe. And I can make trees and other plants grow more slowly. But here's the *most* rotten thing I do: When I get way up into the air, I mix with water in the sky, and presto! You get acid rain! *(sprays water at the audience)*

Harry: Acid rain is a big problem. It can kill fish and other animals that live in lakes and rivers, and some scientists think it makes trees sick. Acid rain can even eat away at statues and buildings.

Sulfur: (proudly) That's right. Hey, I can even travel a long way to do my dirty work. If I get pumped out of a smoke stack in Ohio, I can ride the wind for hundreds of miles and turn up as acid rain in Vermont!

(Sulfur Dioxide returns to the picket line. Nitros walk over.)

Harry: (*to the audience*) He's really rotten!

Nitros: (all together) You think Sulfur Dioxide is rotten? You haven't met us!

Connie: You must be the Nitrogen Oxides.

Nitro 1: Just call us the Nitros for short. *(turns to the audience)* Give me an "N"!

Audience and other Nitros respond: "N"!

Nitro 2: Give me an "I"!

Audience/other Nitros : "I"!

Nitro 3: Give me a "T"!

Audience/other Nitros: "T"!

Nitro 4: Give me an "R"!

Audience/other Nitros: "R"!

Nitro 5: Give me an "O"!

Audience/other Nitros : "O"!

Nitro 1: What's that spell?

Audience/other Nitros: NITRO!

Nitro 2: What's that mean?

Other Nitros: DIRTY AIR!

Harry: Hey, I didn't know pollutants could spell!

Nitro 4: Very funny, Harry.

Connie: So, how do you Nitros get into the air?

Nitro 5: We get airborne when cars, planes, trucks, and power plants burn fuel.

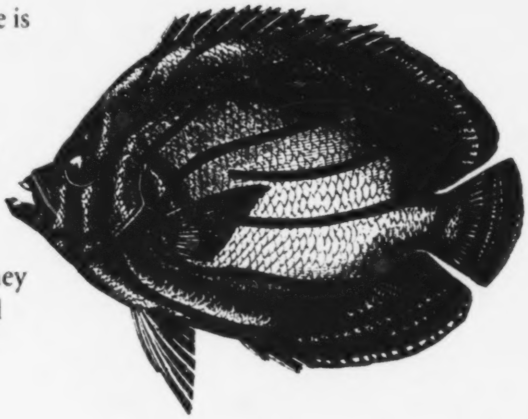
Harry: And what happens once you're in the air?

Nitro 1: We can make people's lungs really hurt when they breathe — especially people who already have asthma.

Nitro 2: And, like Sulfur Dioxide, we mix with water in the air and form acid rain.

Nitro 3: But we also make another form of pollution. And here she is — BAD OZONE!

(Bad Ozone waves and walks over. Nitros return to the picket line.)



Bad Ozone: City life — I love it! The sun, the soot, the smell of car exhaust! It makes me come alive.

Connie: Exactly how do you "come alive"?

Bad Ozone: Well, when my friends, the Nitros, pour into the air, they get together with some other pollutants. As the sun shines on all these lovely pollutants, it heats them up — and creates me, bad ozone. And where there's ozone, there's smog.

Harry: (to audience) Smog is made up mostly of ozone.

Connie: That's right, Harry. And smog can really make city life miserable. It can make your eyes burn, your head ache, and it can damage your lungs.

Harry: But what I want to know is, if ozone is so bad, why are people worried about holes in the ozone layer?

(Good ozone walks in from offstage.)

Good Ozone: That low-level ozone is my rotten twin sister — she's just a good gas turned bad! I'm the good ozone that forms a layer high above the earth. I help absorb the harmful rays of the sun.

Bad Ozone: (nastily to Good Ozone) So what are you doing here, Sis?

Good Ozone: I'm here to *support* the clean air laws. If certain chemicals keep getting pumped into the atmosphere, I'll disappear. And without me, the harmful rays of the sun will kill some kinds of plants and give many more people skin cancer and eye disease.

Harry: But what kinds of chemicals are making you disappear?

Good Ozone: It's those terrible CFCs!

In Hungary, about one in 17 people die from air pollution-related causes.

—State of the Environment
Hungary, 1989

(CFCs walk over from picket line.)

CFC 1: Hey, we're not so bad! People have always used us CFCs to make *(point to different parts of costume)* plastic foam cups, fast-food containers, packing material, coolants for refrigerators and air conditioners — all kinds of things. *(throws "peanuts" into the audience)*

CFC 2: So what if we destroy a little bit of ozone? There's enough to last for years!

CFC 3: Yeah — who needs ozone anyway?

Good Ozone: People do! Tell them what else you CFCs are doing!

CFC 4: What's Ozone talking about *now* — global warming?

(EPA Scientists walk in from offstage. Good and Bad Ozone walk offstage.)

Scientist 1: Excuse me, but did I just hear someone mention global warming?

CFC 2: Yeah. What do *you* want?

Scientist 2: We just happen to be experts on global climate change.

Connie: Are CFCs really changing the world's climate?

Scientist 1: Well, we're not positive. But over the past 100 years or so, we've poured gases, such as CFCs and carbon dioxide into the air.

Scientist 2: And as they build up in the atmosphere, these gases may be acting like the glass in a greenhouse.

Scientist 1: That's right. They let the radiation from the sun in — but they keep the heat from getting out. And this may be causing the earth's climate to become warmer.

Harry: I've read that if the temperature goes up, sea levels may rise. Wow, some cities on the coast might be under water some day!

Scientist 1: It's certainly possible.

Scientist 2: Well, nice talking with you all, but we've got to do some more research so that we can really nail these pollutants. *(Points to CFCs. CFCs give scientists a dirty look, stick out tongues. Scientists walk off stage.)*

CFC 1: Hey, we're not even the biggest cause of global climate change. You gotta talk to another of the big pollutants about that.

Harry: There's only one other pollutant on the list — Carbon Dioxide.

(CFCs return to picket line. Carbon Dioxide 1 and 2 walk over.)

Dioxide 1: Did we hear you mention our name? We didn't used to be thought of as a bad gas. About a hundred years ago, there was just the right amount of us in the air.

Dioxide 2: But then people started burning things — they built power plants that burn coal and cars and trucks that burn gasoline. And they started cutting down and burning forests! Every bit of that burning releases us into the air.

Dioxide 1: As more and more of us got into the air, people started saying that the earth was warming up—because of us!

Dioxide 2: Yeah — like it's our fault! *(to audience)* The reason you're in such a mess is because you use so much fuel and cut down so many trees!

Connie: You're right, Carbon Dioxide. Maybe we should be doing a special report on people — we're the ones who are really causing air pollution.

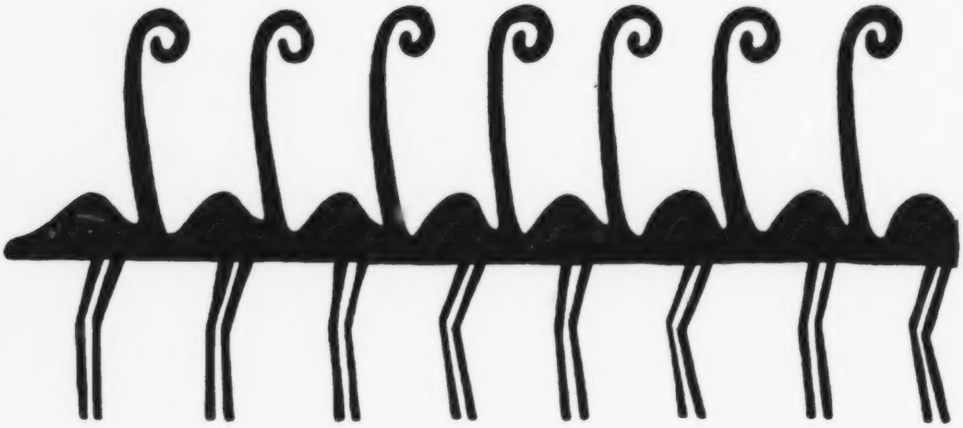
Harry: But people can change! *(turns to audience)* How about you? Can you think of some ways that people can help fight air pollution?

(Audience responds with ideas such as driving cars less, using less electricity, conserving forests, planting trees, and so on.)

Connie: And that's the end of our special report. The bottom line? These air pollutants are a pretty tough bunch—but people create them, and people can get rid of them. Thank you and good night.

Pollutant Curtain Call

The End



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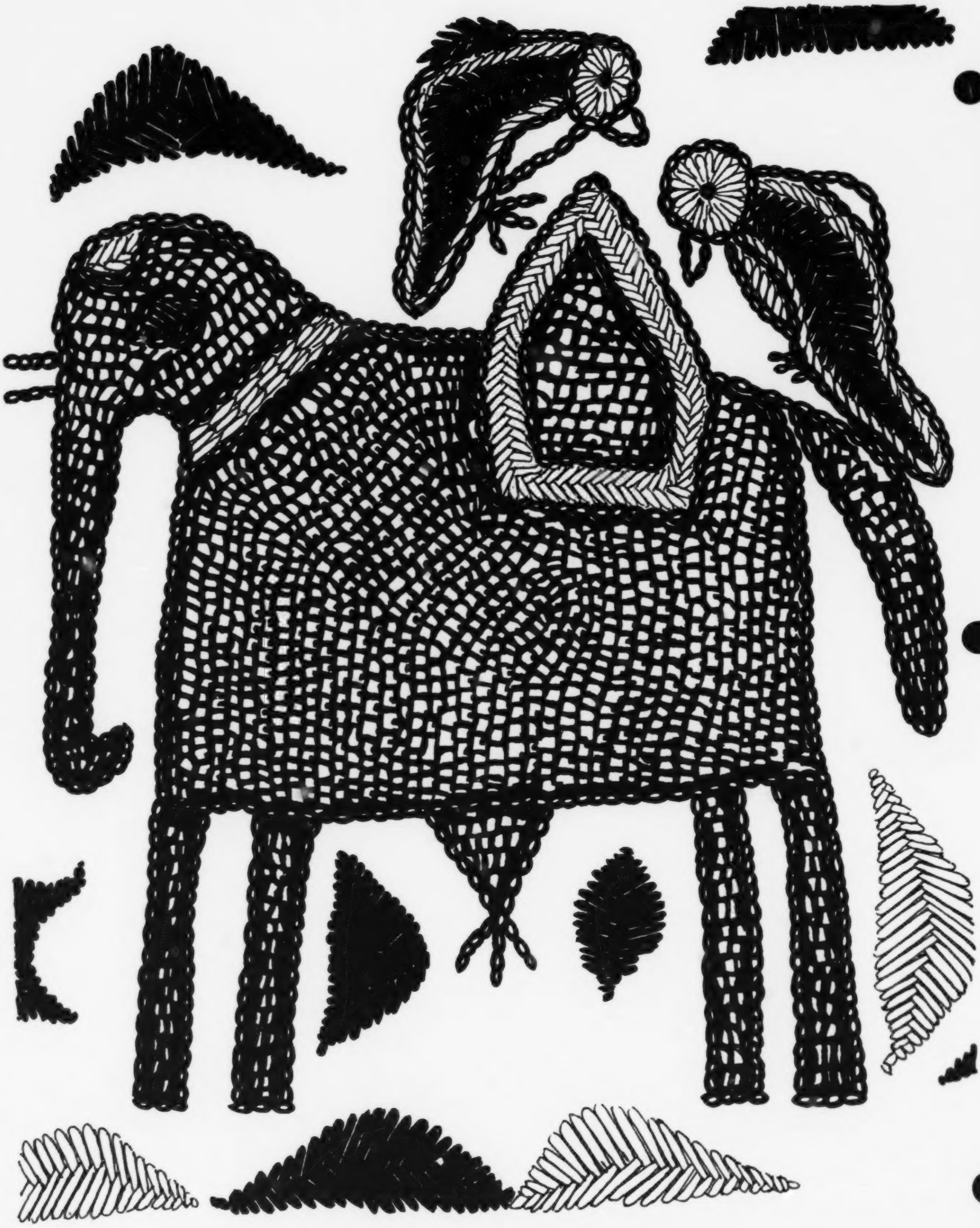

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ROLE PLAYS AND OTHER SIMULATIONS

3.

It is easier to go to Mars or to the moon than it is to penetrate one's own being.
—Carl Jung

Simulations and role plays are two dynamic techniques that can actively involve the students in the issues and concepts you are trying to teach. Simulations are contrived activities based on real situations that help students understand a complicated process or interaction. They are designed to present complex information in an easier-to-understand and exciting format. For example, a simulation focusing on the concept of food webs might use a running game strategy where students take on predator-prey roles and look at food choices. Or a simulation focusing on conflict resolution techniques might pose a fictitious case and lead students through a conflict resolution process.

Sometimes simulations can go overboard. Students get so wrapped up in the contrived game or activity, that they forget or lose track of what it is they're supposed to be learning. The best way to know if a simulation is effective is to field test it with several classes and formally or informally test the students to see if they understood the concepts you were trying to get across.

A role play is a type of simulation that allows students to step outside their normal perspective on an issue and get into someone else's "skin" to better understand more about how that person feels about a given issue. By taking on specific roles and trying to make decisions based on those roles, students can learn more about an issue and the sources of conflict.

Just as with simulations, it's important to realize the limitations of a role play. Even when information is supplied, students cannot realistically take on another person's role completely—especially a person's value system and way of thinking. So you can't expect a student playing a role to act in the same way a real person in that situation might act. (For example, if a student is trying to understand an environmental conflict that caused many people to lose their jobs to protect an endangered species, and he or she takes on the role of an unemployed worker, it's impossible for the student to truly understand how it feels to lose a job and have the responsibility of supporting a family, especially if the student or his or her parents never lost a job or don't have to worry about money.) What role plays can do is help students gain perspective and appreciate the complexity of environmental problems.

We have included several samples of role plays and simulations revolving around environmental concepts and issues. The first is a simulation focusing on limited resources and sustainable harvests. The second and third activities focus on island development and include a simulation and role play. And the last activity is a role play about mining limited resources on the moon.

You might also want to request a copy of the following role play for older students (secondary and university) focusing on biosphere reserves and international public policy. (It was too long and complex to include here.) You can write to:

The Biosphere Reserve Simulation—An Exercise in Sustainable Development by Richard Butgereit, Jennifer Gore, and Robert Wildey, under the direction of Dr. Sandra Gilchrist, New College, Sarasota, Florida.

ACTIVITIES IN THIS SECTION

1. **THE COMMONS DILEMMA**, by Maura O'Conner. From *Living Lightly on the Planet—Volume 1.* Used with permission through arrangement with the Schlitz Audubon Center of the National Audubon Society, 1111 East Brown Deer Road, Milwaukee, WI 53217. Copyright material. All rights reserved.
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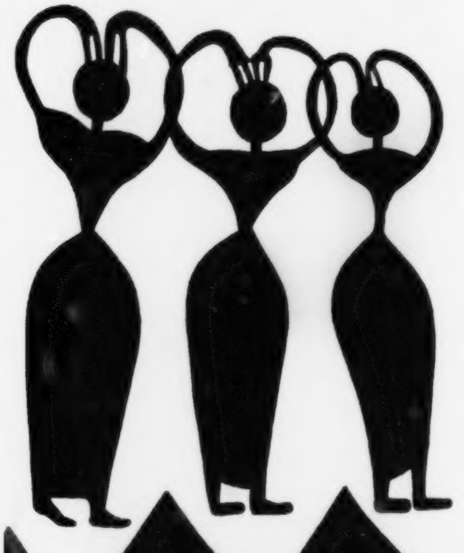
3. **KEY MANGROVE: A CONFLICT OF INTERESTS**, reprinted with permission from *The Class Project* published by the National Wildlife Federation and the National Science Foundation.
4. **MINING ON THE MOON**, reprinted with permission from *Ranger Rick's NatureScope—Astronomy Adventures*, published by the National Wildlife Federation (1988).



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THE COMMONS DILEMMA

The interrelated problem of population growth and dwindling resources is illustrated in this demonstration of the "commons dilemma." Christened by Garrett Hardin, the commons dilemma is derived from *The Tragedy of the Commons* written by William Forester Lloyd in 1833. The commons described by Lloyd is a pasture open to all. Herdsmen bring cattle to the commons to graze. Over time, each herdsman seeks to maximize his economic gain and adds cattle to his herd. The positive component, the increased profit, is realized by the individual herdsman. The negative component, the resultant overgrazing, is shared by all who use the commons. As each seeks to maximize his gain, the commons resource declines until overgrazing leads to its destruction. The dilemma: self interest vs. cooperation or maximizing individual gain vs. cooperative stewardship of a resource.

In this simulation, your students will have an opportunity to demonstrate their response as consumers of a resource in a commons. The commons, a large bowl, represents the sea and the resource, fish, are represented by peanuts or some other material.

Introduce the demonstration with a discussion of the ground rules, supplying only the information needed to get students started. The dilemma and a discussion of the various strategies should surface at the outcome of the activity. Divide students into groups of four and give each a bowl with 16 "fish."

OBJECTIVES:
Demonstrate how increased population places a strain on natural resources. Describe the outcomes of a self-interest strategy vs. a cooperative strategy for managing renewable resources. Explain how our stewardship of a resource can help to prevent us from exceeding the carrying capacity of the earth.

AGES:
Intermediate, advanced

SUBJECTS:
Science, social studies

MATERIALS:
Two pounds of peanuts in the shell, one large bowl for every four students

GROUND RULES

1. The object of the game is to harvest as many fish as possible from the sea.
2. At carrying capacity, there are 16 fish (peanuts) in this sea (bowl). For every four fish each student harvests, he/she will receive one point. The more fish you harvest, the more points you will receive.
3. When the game begins, you may harvest all of the fish, some of the fish, or none.
4. You will have four twenty-second trials in which to harvest fish. You will be notified when to start and stop each trial.
5. If fish remain in the sea after each trial, a new fish will be added for each one remaining. If there are four fish left, four more will be added. But for each new trial, the total number of fish in the sea cannot be more than the carrying capacity of 16 fish.

Repeat the demonstration with eight students in each group to simulate population growth. Keep all other factors constant.

(Reprinted from *Living Lightly on the Planet—Volume 1*, Schlitz Audubon Society)

DISCUSSION QUESTIONS

- What were the maximum number of points achieved by any individual? Any group?
- Why were fish only replaced if some remained in the bowl after each trial? (Simulates natural conditions; if all fish are harvested, no additional fish will be born.)
- What happens when members of a group do not use a cooperative strategy?
- What was the best strategy for harvesting from this commons? (Eight from each trial.)
- Stewardship of a resource is demonstrated when we use a cooperative strategy that shows concern for a resource. Name some other resources that require our stewardship.
- How will continued population growth affect our stewardship of the Earth's resources?

Note: This demonstration was adapted from a study done by Robert Gifford of the University of Victoria. Gifford found that groups of children tend to cooperate or fail to cooperate, but not to cooperate partially. Cooperation increased with age, but there was a decline in quality of resource management from age 14 to 16.

EXTENSIONS

There is not universal agreement on whether population control is a desirable goal. Economist Julian Simon from the University of Illinois sees the prospects for population growth in a positive light. He views the contribution of additional people to the human race as increasing the human capacity to discover new resources and increase productivity.

> *"In the long run, the most important economic effect on population size and growth is the contribution of additional people to our stock of useful knowledge. And this contribution is large enough in the long run to overcome all the costs of population growth. . . ."*
>
> Julian Simon, *The Ultimate Resource*

Present Simon's point of view and let students debate the issue. For further reading on this point of view, see Simon and Kahn in the reference section of *Living Lightly on the Planet.*

Explore the "Tragedy of the Commons" being carried out by the exploitation of whales. The commons analogy is particularly poignant in this case as the economic interest of the whaling industry prevails over the long-term stewardship of these magnificent animals.

(Reprinted from *Living Lightly on the Planet—Volume I*, Schlitz Audubon Society)

TAKING ACTION

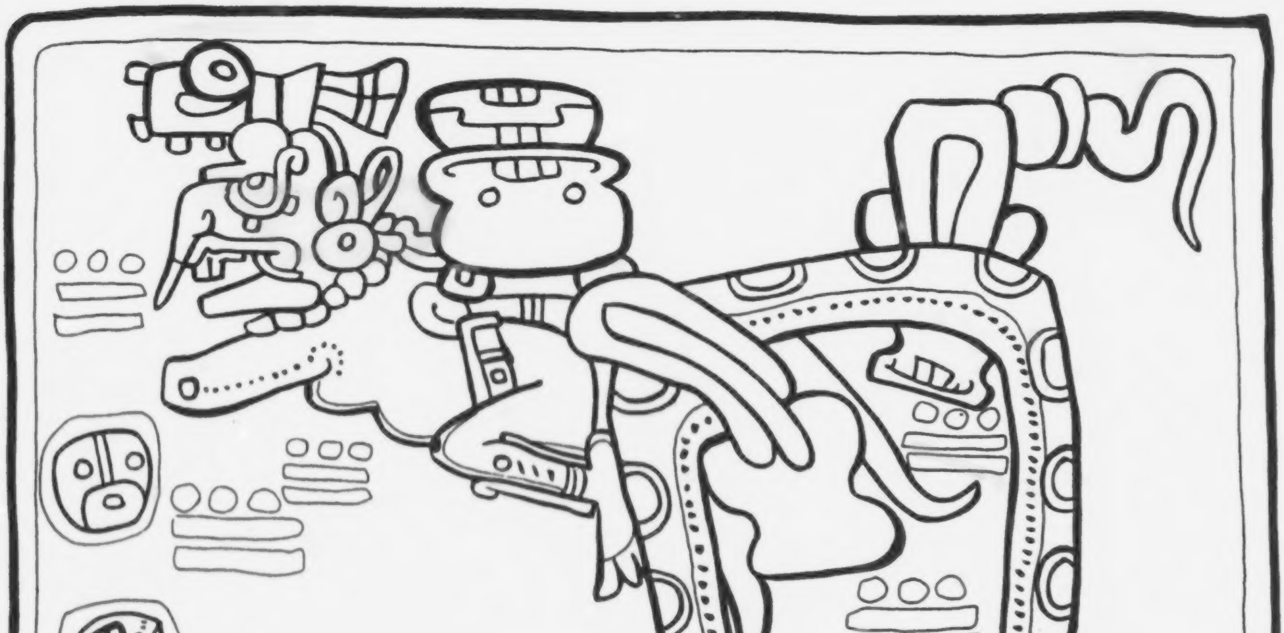
> *Individually, each of us can do only a little. Together, we can save the world.*
>
> —Denis Hayes
> Founder, Earth Day

Is there a commons dilemma to be resolved in your community? A commons is any publicly owned or shared resource, such as a forest preserve, an aquatic area, or the air we breathe. A dilemma results when population growth places pressure on the commons through overuse or misuse of a resource, causing the resource to become threatened or damaged. For instance, as population in an area grows, the addition of each car creates more air pollution, and the air quality for everyone declines. More people also means more public use of parks which often results in overuse of trails, more litter, and more pollution of waterways.

Have students select a local commons issue to investigate. Some dilemmas might revolve around the following situations: a decline in fish populations due to overharvesting; additional use of motorboats and other recreational equipment in a local aquatic area resulting in noise and/or water pollution; or destruction of trails in a local park due to increased usage by the public.

Once students have identified the problem and collected data, they should determine which laws exist to protect the resource they are investigating. Then use the guidelines provided in the introduction to try and solve the problems. The question of how to balance use with conservation of a resource is the central issue of a commons dilemma.

(Reprinted from *Living Lightly on the Planet—Volume I*, Schlitz Audubon Society)



KEY MANGROVE: A SYSTEM IN CONFLICT

The maps on pages 144-145 depict changes that have occurred over a period of 30 years in a hypothetical wetlands area, Key Mangrove. Introduce the first map using the information given under "Change in a Mangrove Ecosystem." All the changes that occurred in this wetland area over the 30-year period are listed for you, but allow your students the opportunity to discover the changes themselves.

A mangrove swamp offers just one example of a wetlands ecosystem. You may prefer to adapt this exercise to focus on other wetlands types, like prairie potholes or bogs, instead.

OBJECTIVES:
Identify ways in which people have changed wetlands. Identify the benefits or harm caused by changes to wetlands. Identify changes to wetlands as temporary or irreversible. Design a balanced plan for development

AGES:
Intermediate, advanced

SUBJECTS:
Science, social studies

MATERIALS:
Key Mangrove illustrated maps on pages 144-145

PROCEDURE

1. Examine all four maps with your students. Use these questions to guide their observations and draw conclusions about the development that has taken place on the island.
    a. Look at the first map. About what percentage of Key Mangrove was covered by mangrove swamp 30 years ago?
    b. Look carefully at the development that has taken place at each 10-year interval. In each case, how has transportation increased? What industries have been added or expanded? How has the residential development increased? What recreational facilities have been added? What public services have been added to meet the needs of the residential and industrial development? What have been the effects of the mangrove swamp on the key itself? Why is the swamp important?
    c. Compare Map #1 with Map #4. What is the percentage of mangrove swamp that remains? (Divide the areas to be compared into grids, then calculate the percentages from the number of grids in each area.)
    d. What percentage of the original mangrove swamp was filled in at each 10-year interval?
    e. What was built first? How did this stimulate the rest of the development?
    f. What has been the effect of this development on the wetlands and the animals living and breeding there?
    g. Do you think the shrimp industry has been affected by the increase in development? In what way?

   h. In what ways could people use the mangrove swamp in its natural state for recreation? In what ways have people altered the mangrove swamp for recreational purposes? How have the recreational uses of the island changed over time?
   i. What immediate benefits are the result of development of the wetland? What are the long-term benefits of this development? Who or what has been adversely affected by the development of the wetlands?
   j. Where could development have taken place on this island without destroying the mangroves? Why do you think more development didn't take place in these areas?
   k. Do you think people who moved in 30 years after development began really know why the island was named Key Mangrove?

2. Now your students are ready to create their own management plans for the island using the first map as their starting point. Generally, their plans should allow for the orderly development of the island and the conservation of its natural features.
   a. Their plans must provide for human needs such as housing, food, schools, recreation, and waste disposal.
   b. Their plans must still protect the natural system, recognizing its aesthetic, economic, and ecological importance.

SUMMARY

When students have completed their plans, share them as a class and use these questions to help them understand the process they used in developing their plans:

1. What development was *not* included in your plans? Why not?
2. Whose needs did you think were most important to consider as you developed your plan.
3. Did you have problems finding a balance between development and conservation?
4. Who do you think would object to your plan? Do you think their objections would be legitimate or would be raised simply to further their own interests?
5. Did you find cases in your planning processes in which the wishes of an individual or small group became more important than those of the whole group? In which cases?
6. What compromises did you make?
7. Look at the original maps. What changes would you make at each 10-year interval? Why?

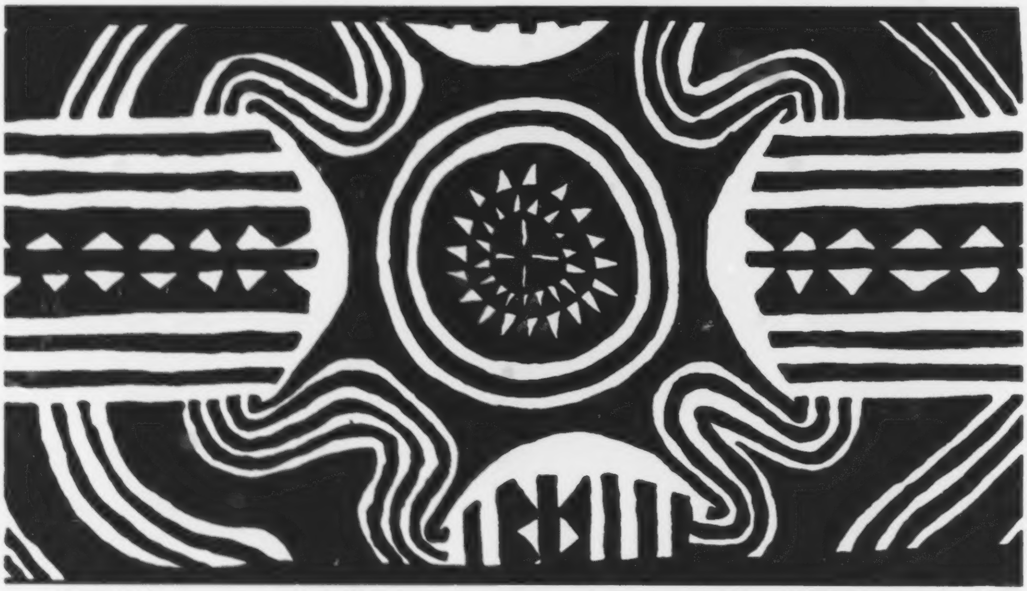
CHANGE IN A MANGROVE ECOSYSTEM

You will notice that 30 years ago the hypothetical island, Key Mangrove, was largely uninhabited. Only four vacation estates had been built on the island. Much of the area was covered by mangrove swamp.

Red mangrove, a tree species adapted to brackish or salty water, covers large portions of this type of swamp. These trees grow easily in water and can be recognized by their arching, stilt-like roots, which are at least partially responsible for the growth of the island itself. The roots trap materials carried by ocean currents and protect the accumulating land mass from ocean waves or hurricanes. The mangrove drops leaves that provide nutrients for the accumulating soil. These dropped leaves also provide habitat and food for the plentiful animal life, from invertebrates to fish, birds, and occasionally, mammals.

A mangrove swamp is a breeding area and habitat for many marine animals, especially shrimp. Many varieties of birds live and breed here. Herons, wood storks, and other wading birds nest here in great numbers. Mollusks, such as coon oysters and Florida hornshells, are in these swamps. Bonefish come in with the tide to feed on the crabs and mollusks living in the shallow water.

Because of the abundance of wildlife and marine life, Key Mangrove was a fisher's and seafood lover's paradise for years. Shrimpers from a coastal town on the mainland fished the waters of Key Mangrove and took their catch to a large packing firm on the mainland for processing. The mangrove swamp is a fragile ecosystem, and its basis, the red mangrove trees, may be affected by slight variations in salinity and in nutrients carried in the water.



154

TEN YEARS LATER

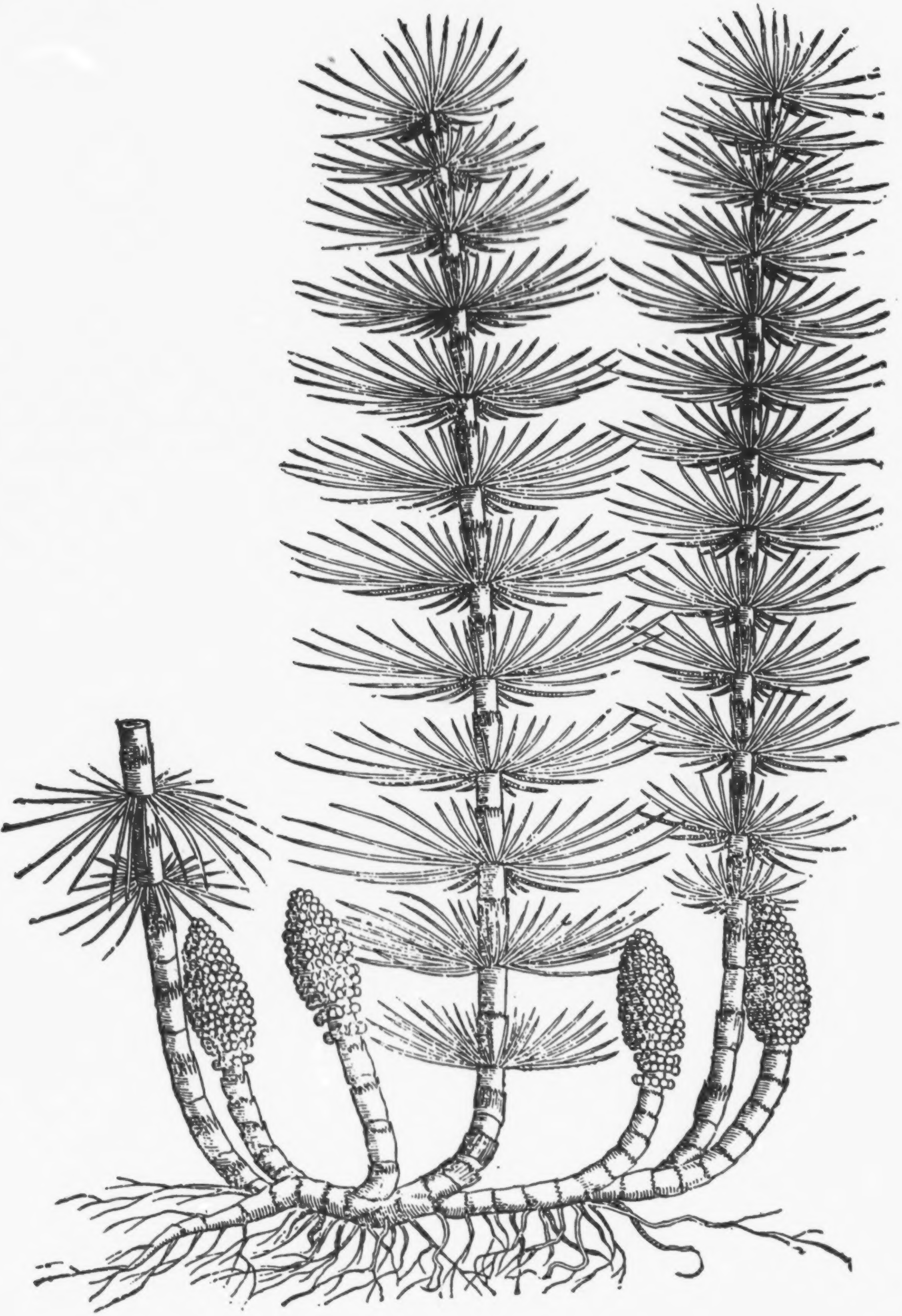
- The ferry has been replaced by a bridge allowing easier access to the mainland.
- Some shrimp fishermen have moved permanently to the island now that a bridge connects it to the mainland.
- A shrimp packing plant has been built.
- A housing development has been built that furnishes homes for the workers at the shrimp packing plant.
- A sewage treatment plant has been built.
- A supermarket and a drug store have been built on the island.

TWENTY YEARS LATER

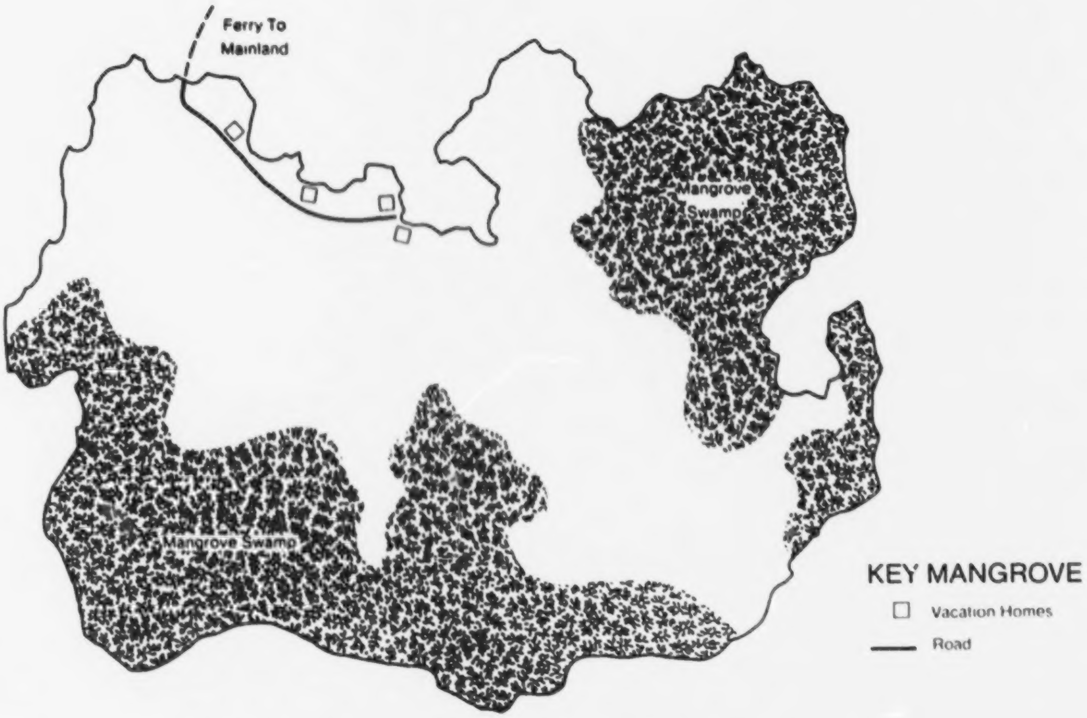
- An oil company has built a refinery on the island.
- The shrimp packing industry has grown and more workers are needed.
- A sanitary landfill has been established.
- More housing has been built for workers at the new plants.
- A shopping mall has been built.
- Two hotels and a marina have been built, increasing tourist trade.
- A school has been built near the new housing development.
- A golf course has been built.

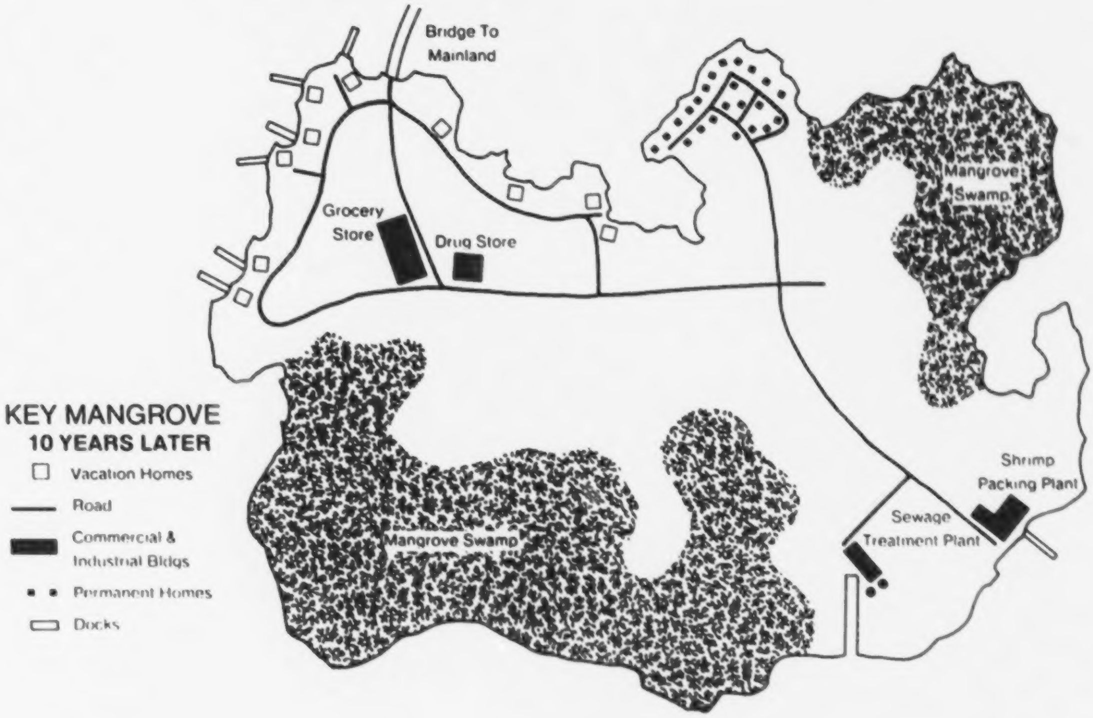
THIRTY YEARS LATER

- Two more hotel complexes have been added and the area is becoming more popular as a vacation spot.
- A large public marina has been opened.
- Another golf course has been built on the eastern side of the island.
- The sanitary landfill has been enlarged.
- A housing development with boat ramps, attractive to sport fishers and water enthusiasts, has been built.
- Another school has been built to serve the growing population.
- A pond has been dredged on the golf course to attract migratory birds.

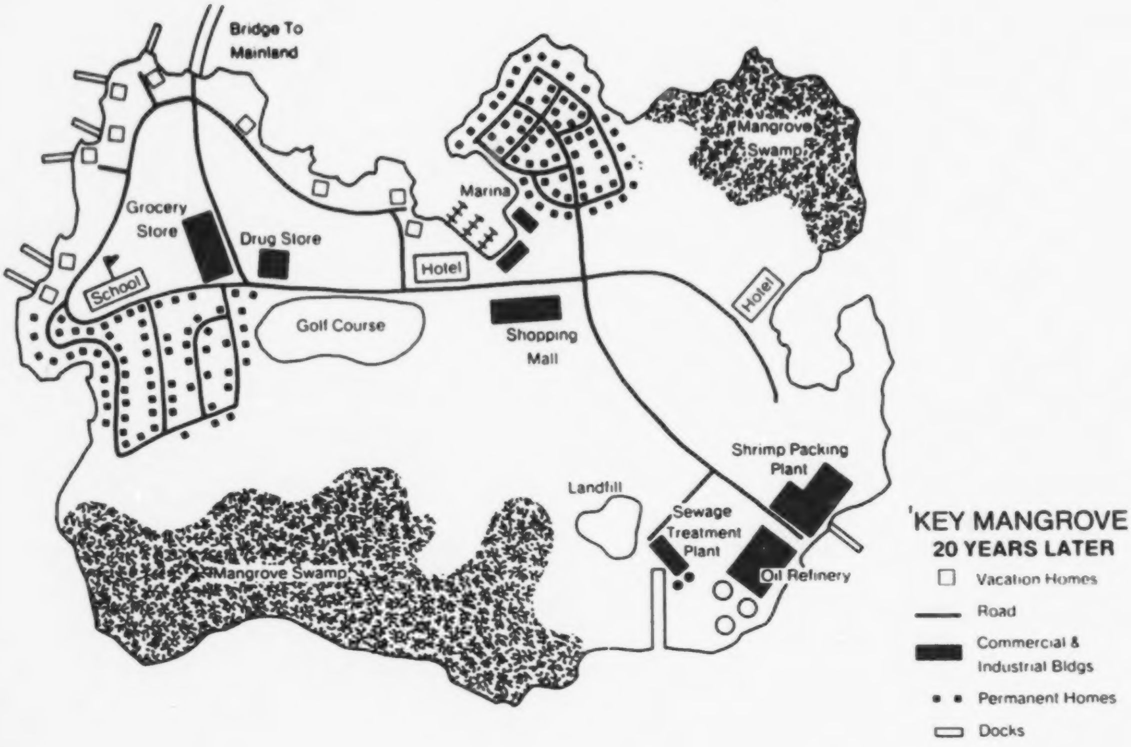


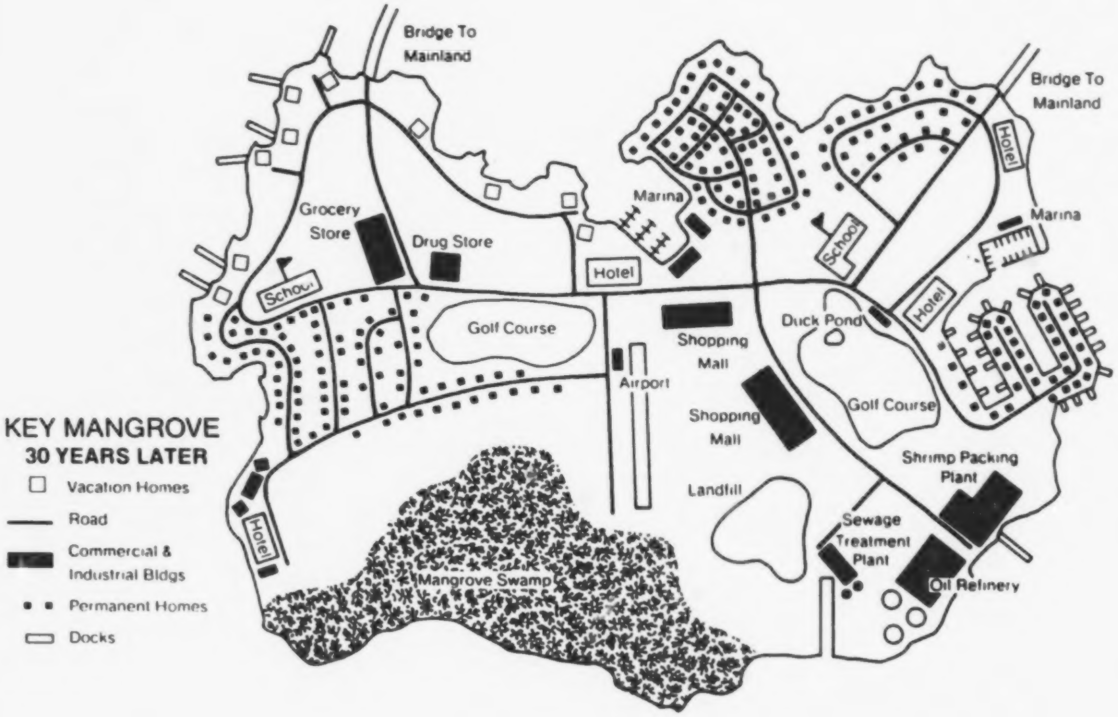
CHANGE IN A MANGROVE ECOSYSTEM


Ferry To Mainland
Mangrove Swamp
Mangrove Swamp
KEY MANGROVE
☐ Vacation Homes
— Road


Bridge To Mainland
Grocery Store
Drug Store
Mangrove Swamp
Mangrove Swamp
Shrimp Packing Plant
Sewage Treatment Plant
KEY MANGROVE
10 YEARS LATER
☐ Vacation Homes
— Road
▬ Commercial & Industrial Bldgs
• • Permanent Homes
▭ Docks

CHANGE IN A MANGROVE ECOSYSTEM


Bridge To Mainland
Mangrove Swamp
Marina
Grocery Store
Drug Store
Hotel
School
Golf Course
Shopping Mall
Hotel
Shrimp Packing Plant
Landfill
Sewage Treatment Plant
Oil Refinery
Mangrove Swamp
KEY MANGROVE
20 YEARS LATER
Vacation Homes
Road
Commercial & Industrial Bldgs
Permanent Homes
Docks


Bridge To Mainland
Bridge To Mainland
Hotel
Marina
Grocery Store
Drug Store
Marina
School
Hotel
School
Golf Course
Shopping Mall
Duck Pond
Hotel
Airport
Shopping Mall
Golf Course
Shrimp Packing Plant
Landfill
Sewage Treatment Plant
Oil Refinery
Hotel
Mangrove Swamp
KEY MANGROVE
30 YEARS LATER
Vacation Homes
Road
Commercial & Industrial Bldgs
Permanent Homes
Docks

KEY MANGROVE: A CONFLICT OF INTERESTS

OBJECTIVES:
Identify the needs of individual residents concerning the mangrove swamp. Explore the problems associated with meeting the needs of all local residents. Design an island development plan that best meets the needs of the people and the environment.

AGES:
Intermediate, advanced

SUBJECTS:
Science, social studies

MATERIALS:
Copies of "Points of View"

The "Points of View" given on pages 148-150 describe the feelings of Key Mangrove residents about the development that has taken place on their island and the possible development that will take place in the future. Have several of your students present these "Points of View" in a play to the rest of the class. The play could portray a town meeting, a rally, or a local newscast in which the residents are interviewed. This will prepare your class to analyze their plans from the viewpoints of the residents.

After the play, ask your class these questions:

1. Do you think the plans you developed as part of the previous activity solve the problems you heard expressed in the play? How?
2. Is it possible to solve all their problems?
3. Which people seemed to have the interests of the entire group in mind? What did they say to convince you of that?
4. Which people were expressing their own special interests? What did they say that made you feel that way?

PROCEDURE

1. Divide your class into groups of six or eight. Give each group a copy of the "Points of View" to help jog their memories.
2. Each group should now combine or revise their plans to make one plan that will best meet the needs of all the residents of Key Mangrove as outlined in the "Points of View." Their plan can be presented as a map, in a written essay, or as another play.
3. Now compare their new plans with the development that actually occurred as shown on maps of Key Mangrove on pages 144-145.
   a. Do students feel that growth on Key Mangrove was excessive?
   b. What could have been done to curb the growth?
   c. How does the development in their new plan differ from what actually happened on Key Mangrove?
4. If students feel that the growth on Key Mangrove was excessive, they should now write a series of regulations that would have ensured better use of the land.
   a. What restrictions would these regulations impose on homeowners? Industry? Recreation?
   b. Who would be responsible for policing and administering these regulations?

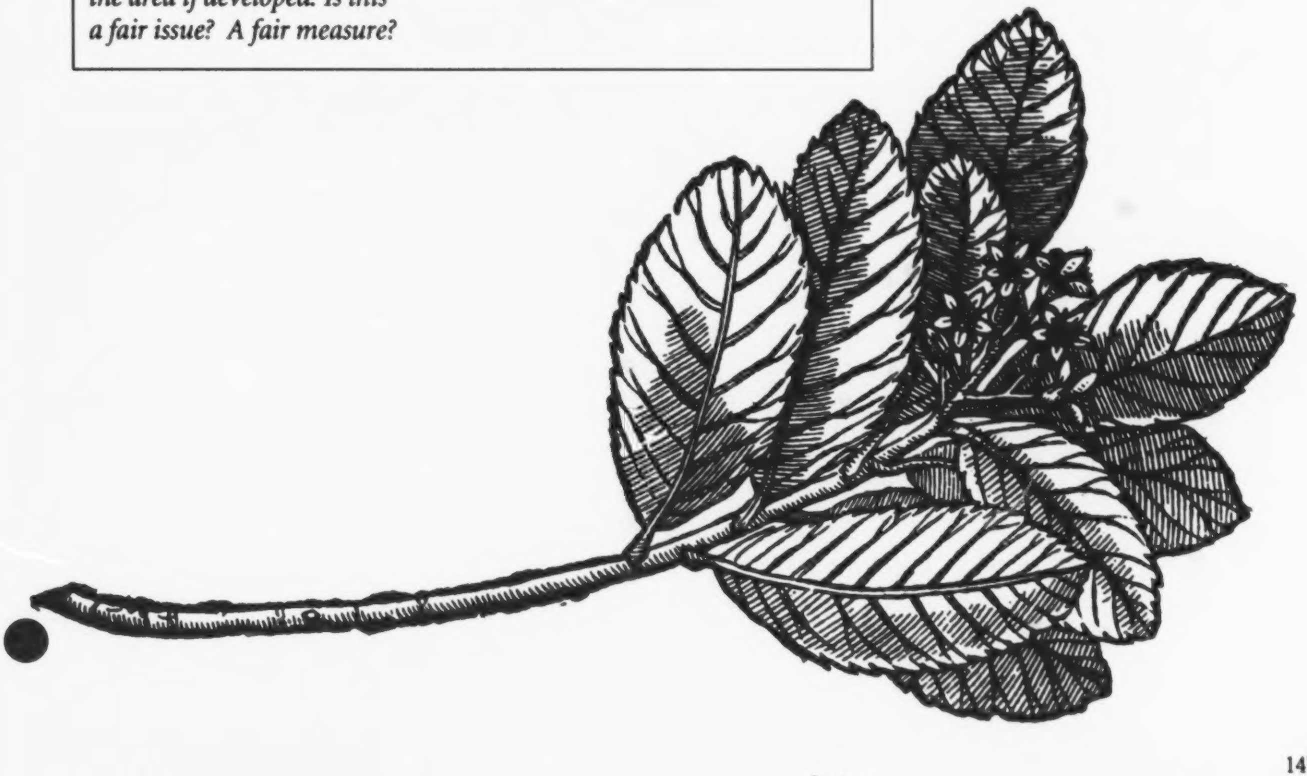
SUMMARY

You may want to have each group present its new plan and new set of regulations to the rest of the class. Each plan could be critiqued and compared with the others.

1. Ask the groups to list the needs they considered (and the interest groups that expressed those needs) in order of the importance they assigned to those needs.
2. Were all the groups able to satisfy all the different points of view of the local people? If not, what was sacrificed? By whom?
3. Did all the groups sacrifice the same thing? Different things of equal or similar importance?*
4. How will the regulations work to benefit the people?
5. What aspects of each group's plan benefited the entire community?
6. Have the opinions of each group or each student changed as a result of listening to each other critique the plans that have been designed?

How does this exercise relate to real-life situations? How do you think compromise and/or decisions are reached in real-life situations?

** This question may bring up the difficulty of placing an economic value on certain recreational pursuits and aesthetic aspects of life. "How valuable is a sunset?" Allow your students to explore this for a while and try to discover a way for the "scenic" value of an area to be measured against the economic value of the area if developed. Is this a fair issue? A fair measure?*



POINTS OF VIEW

VACATION HOMEOWNER #1

"I have been coming to this island for fifteen years and I like it the way it is. I want complete peace and quiet on my vacation. I want to see wildlife and nature undisturbed by human activity. This island is one of the few remaining mangrove habitats for many different kinds of wildlife. Sure, we can destroy this swamp, but how do we know what is happening in other places? How can we make sure there is a place for our wildlife? I think it's about time we accepted our responsibility for the wildlife that has come to depend on us."

VACATION HOMEOWNER #2

"On my vacation, I want to swim, boat, have fun with my friends—I like excitement and nightlife."

CHAMBER OF COMMERCE MEMBER #1

"My business depends on tourists and residents spending money in my department store. I am interested in developing this island in such a way that more people will live here and spend their money in my store. It is important to me to have industry, hotels, and housing developments. Without the people who use these facilities, I would go broke, and I have a family to support. This is my livelihood."

CHAMBER OF COMMERCE MEMBER #2

"My business depends on sports people. I sell fishing gear, boats, and sports equipment. I am interested in developing this island in such a way that people interested in these kinds of sports will visit it. Therefore, I don't want to see all of the swamp filled in and developed into golf courses, hotels, or airports. That will put me out of business. My business is to supply the sportsmen, hikers, and other visitors who just want to enjoy nature and to explore the island. These are the people I want to attract to the island."

HOTEL OWNERS REPRESENTATIVE

"I have a 500-room hotel which needs to be 70% filled in order for me to make a profit. You figure out how many rooms need to be filled for me to stay in business profitably. We need attractions for them. We need golf courses and marinas. We need landing docks and moorings for people who come in their own boats. We need parking lots and stores for these people. We need attractions that are going to make people want to take their vacations here at my resort. Therefore, we cannot afford to keep these swamps as they are. The swamp has mosquitoes and it smells bad. You can't swim in it and it is not going to attract people to my hotel. I suggest that we fill it in and build a new golf course. We could use another one."

AUDUBON SOCIETY MEMBER

"I am interested in wading birds and shore birds. If we can keep the swamps as they are and keep the mangrove trees, these birds will come to breed and raise their young. They are a very important part of our environment. If the swamp is destroyed we will lose many different kinds of birds, and the island people will lose the $3 million worth of business brought by people who want to visit the swamp. People like me take canoes and quietly observe birds and other animals and their habits, take photographs, and write about them. We can't do this if you destroy the swamp. I do not want to see this land developed."

SHRIMP PACKING PLANT OWNER

"My business depends on a plentiful supply of shrimp. We will not have these shellfish any longer if we continue destroying our mangrove swamps for hotel development, golf courses, private homes, private docks, and the roads and shops you people are planning. We can always put oil refineries and hotels somewhere else, but we can't put shrimp just anywhere. This is a $12 million business on this island! If we destroy the shrimp habitat, I will go broke. My plant will have to close and my employees will be out of work. Just think how high the unemployment rate will be! Then people won't have money to spend on local businesses."

PRESIDENT OF THE SHRIMP PACKERS UNION, LOCAL 461

"My people earn their living processing the shrimp that are caught off the shores of Key Mangrove. When I was first a member of this union, the shrimp boats used to bring in 80 tons of shrimp a day to be processed in the plant. We had 200 people working here. Since the bridge was built 20 years ago, more development has occurred and there have been fewer areas for the shrimp to grow. The number of people who work in the shrimp packing plant has been reduced to 100. A hundred people are out of work because of the development that has been allowed on this island. At this point people want to develop more of this land, to take away more of the shrimp habitat and the mangrove swamps. If you do this, you are going to put 100 more people out of work."

BIOLOGIST FOR THE FISH AND WILDLIFE SERVICE

"I have been sent here to study the organisms that live in and depend on the mangrove swamp. I have done extensive studies on shrimp, coon oysters, and bonefish, and I have found that these organisms would be eliminated if the mangroves are destroyed. The swamps are also an essential habitat during part of the life cycles of many other organisms. Destruction of these swamps would ensure destruction of many varieties of wildlife that depend on the swamps. Until we fully understand the importance of mangroves, we cannot afford to do anything that would destroy them. The shrimp and

commercial fishing industries would also be destroyed along with local businesses that are supported by people who want to canoe and look for wildlife in the swamp. We could be creating more problems than we are solving if we destroy the swamps."

PERMANENT HOMEOWNER

"I spent a lot of money for my house. When I moved to this development on Key Mangrove, it was rather exclusive. We had a marina. Our homes were on the golf course. We had our own docks. We had all the advantages of privacy and yet all the conveniences of a resort hotel down the street with nice boutiques and shops where I could take my guests when they came on the weekends. There was not much traffic and our property was increasing in value because of the type of development here. Since that time an oil refinery has moved in. We have an airport. The development is encroaching on our privacy. More and more people are coming to the island and causing traffic problems and pollution. I just wonder if our land values are going to be maintained if we allow any more of this kind of development. I don't want to see any more industry or anything that will detract from its exclusive aspects."

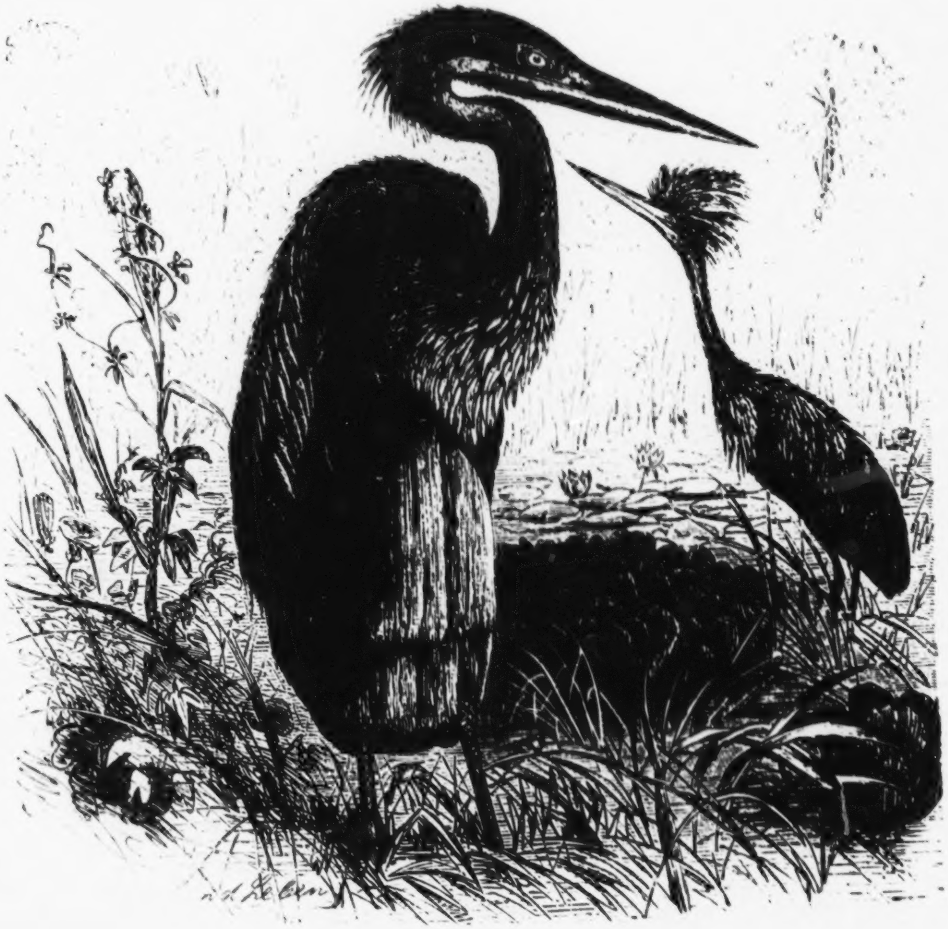
OIL REFINERY MANAGER

"When we built our refinery here, I was told there would be plenty of facilities for my workers, that there would be places for their families to live, and that I would have no trouble finding people to work here because of the location. We need more low-cost housing for our employees, and I want to see that dirty old swamp—that smells worse than any oil refinery ever did—filled in. And I want to see homes and facilities built there for the people who are going to work in my plant. Otherwise, we are going to have to close and find a place that will take us.

Now that I am here in operation, I find there are a lot of environmentalists, bird-watchers, and people who like to fish and hunt, but they don't have any consideration at all for the person who has to earn a living by working here. They don't consider the fact that in order for them to enjoy their activities, they need somebody to refine the oil for their powerboats, trucks, and cars."

BANK PRESIDENT

"Well, I think we need to have a bit of rational talk around here. I find that an awful lot of my customers are sitting here in this room today. Obviously you all have different interests, but you do have three things in common: you all need to earn a living, and you all need a place to live, and places to buy goods and services. My job is to run the bank, to give you services that allow you to do all the things each and every one of you wants to do. Now, when it comes down to the bottom line, you've got to be practical. In order to feed your kids and get the luxuries in life that you all seem to want, you're going to have to have industry, you're going to have to have business, and you're going to have to take some of these unpleasant lands and develop them. Now, it's not a matter of sentiment, and it's not a matter of those nice birds, nice animals that live there in the mangrove swamp. It's a matter of dollars and cents and your livelihood. I suggest that we all sit down and get together and decide that we are going to do something that is going to keep your bank operating for you people who need the money that it generates."



BEST COPY AVAILABLE

MINING ON THE MOON

OBJECTIVES:
Create a proposal about mining rights on the moon based on a hypothetical situation. Discuss some of the problems that might be involved in managing natural resources in space.

AGES:
Intermediate

SUBJECT:
Social studies

MATERIALS:
Copies of pages 154-155, pens or pencils, easel paper

As we continue to travel in space and explore new worlds, ethical questions about how we use space are becoming more important. For example, should space be used for military purposes? Should countries be allowed to dump hazardous waste into space? Should all countries share space technology? In this role-playing activity your group will get a chance to discuss a hypothetical situation dealing with resources on the moon.

Before starting the activity write out the names of the five imaginary countries (see page 154) on separate slips of paper. Also write the names of each country at the top of a separate sheet of large easel paper to use later in the activity.

Now divide your group into five teams and have each team pick one of the slips of paper. Explain that each team will represent the country listed on the slip they drew. But before they find out about their countries, tell them to listen carefully to the following scenario:

> *It is now the year 2098. Government officials from five different countries have gathered to discuss the problem of dwindling supplies of titanium, a lightweight, strong metal. For the last 89 years, countries have prospered using this metal. It has been used extensively in the manufacturing of cars, planes, buildings, and almost every kind of machine. But a problem has developed. The world's supply of titanium is disappearing very quickly. Some estimates say 99% of all minable titanium will be used up by the year 2100 . . . just two years away.*
>
> *However, on a recent trip to the moon, astronauts from Alpha, the largest and most populated country on Earth, discovered two large deposits of titanium beneath the lunar surface. Scientists believe that even larger deposits of titanium exist in many other places on the moon. The five countries are excited about this news, but they must decide how to regulate titanium mining so that everyone benefits from the discovery.*

Now pass out copies of pages 154 and 155 to each "country." Explain that each team, based on the country they represent, must decide how the titanium resources should be managed, mined, and distributed. To do this, they must read the description of their country to find out what resources they have and then work out a proposal that will satisfy their country's needs and continue to maintain world peace.

Encourage the members of each team to discuss the situation among themselves and work together to fill out the proposal on page 155. Tell each team to read over the information about the other countries to help them complete their proposal.

> *It is no use hearing arrogant demands by one group of countries, or refusals to share by others. Resources are not infinite.*
>
> —Mostafa Tolba

When all the teams have finished, hang up the five large sheets of easel paper in the front of the room and ask one person from each team to come up and read the team's proposal. Jot down the main points of each proposal on the appropriate sheet of easel paper. After the kids have had a chance to listen to the other proposals, ask which one they think would work best and why. Then ask the kids to "step out of their roles" and discuss the pros and cons of each proposal. Here are some other things you might want to discuss as the group is evaluating the proposals:

- Have the kids think about how developed and less-developed countries would respond to this issue. (Point out the differences between Alpha and Sigma and then between the U.S. and India.) Talk about the importance of international cooperation (summits, the United Nations, international treaties).
- Discuss recycling as a strategy (refer to the Deltan example) and explain how conserving a resource lengthens the amount of time it can be used until alternative resources or strategies are developed.
- Ask what would happen if a lot of countries mined titanium on the moon and took as much as they pleased. Talk about how a resource can quickly become scarce if it is not managed wisely.

As a final discussion, you might want to talk about the Space Treaty of 1967. Explain that this treaty was signed by more than 70 countries and declared space a free zone which no country can own or use for military purposes. It also emphasized the use of space for peaceful purposes. Ask your kids if they think our country or other countries are sticking to this treaty, and if they think a space treaty is a good idea.

MINING ON THE MOON: PART 1

COUNTRY INFORMATION CARDS

ALPHA

Your country is one of the largest countries in the world and has the most advanced space technology. It was the first to discover titanium on the moon. At present, it's the only country with the technology to mine the titanium on the moon. Your country and Beta are the only ones that can travel to the moon.

SIGMA

Your country doesn't have as many big cities or towns as other, more powerful countries have. The capital is a large, modern city, but most of the other cities in your country are small and have few factories.

Your country is made up mostly of farmland and rain forest. Dirt roads still run between most places. Ten years ago the country built its first car factory. Many different kinds of factories are planned for the future. Sigma desperately needs titanium for national growth.

GAMMA

Your country is a large industrial country but doesn't yet have a space program. It has the most advanced technology for mining and exploring Earth's titanium, and could develop mining equipment for the moon. Gamma is the largest producer of machines in the world, and many other countries import their machines from this country.

DELTA

Your country is a small but major industrial country. It uses titanium in all of its factories. By developing a new recycling technology, Delta has been able to stretch its supply of titanium. Other countries would profit from this technology.

BETA

Your country is very big and has a growing population. It desperately needs titanium to keep its economy strong. Beta can travel to the moon, but it doesn't yet have the technology to mine titanium.

MINING ON THE MOON: PART 2

WITH REGARD TO TITANIUM MINING ON THE MOON, WE THE PEOPLE OF ______________________ PRESENT THE FOLLOWING PROPOSAL TO THE CONGRESS OF NATIONS:

1. The following countries should have mining rights to the moon:

2. We feel these countries should have mining rights to the moon because:

3. To make sure that our country gets the titanium it needs for the future, we will:

4. The other countries will get titanium in the following ways:

5. To make sure that these mining agreements will not threaten world peace, we will:

SIGNED: ______________________

SIGNATURES OF PROPOSAL TEAM

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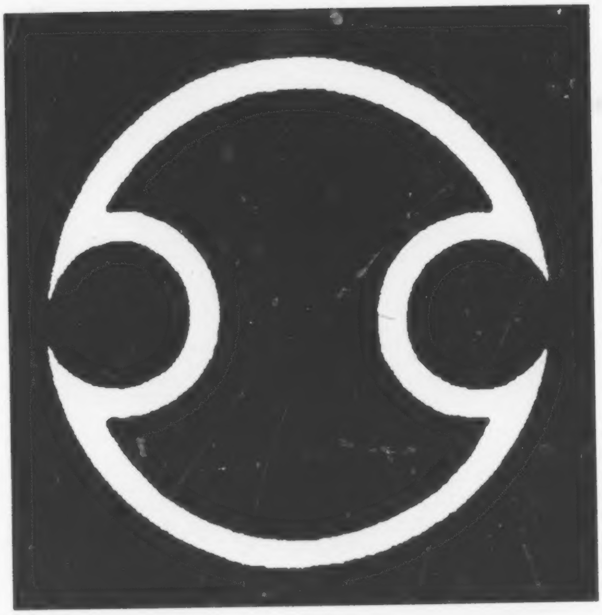


THE READING AND WRITING CONNECTION

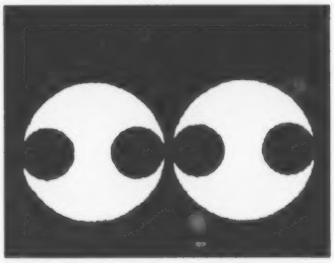
4.

> *I write to find out what I'm thinking, what I'm looking at, what I see, and what it means. What I want and what I fear.*
>
> —Joan Didion

Reading and writing skills are an important part of all curriculum programs throughout the world. In many ways, environmental education is the perfect vehicle for motivating students to practice these skills. By introducing natural history and environmental themes into reading and writing assignments you can liven up a lesson and add much needed relevance. From analyzing a position paper on air pollution to writing a persuasive letter to the editor, reading and writing skills are also critical tools for an environmentally literate citizen. And there are dozens of ways to make reading and writing activities come alive, from having students write fictional stories, nonfictional articles, fantasies, editorials, journal entries, essays, and captions that deal with environmental topics to reading and analyzing newspaper articles dealing with local environmental problems.

Environmental reading and writing activities can also act as motivators to help students struggling with a second language. In many parts of the world, students are tested in a second language and need as much help as possible to become proficient. Creative language activities can help them. Journal activities, such as the one suggested here, can help students practice their writing without feeling threatened.

In this section, we've included two sample folk stories, one written by Hindowah Kamara from Mali and another written by Rona Leventhol called "The Cricket Story," which includes a variety of follow-up activities that show how a story can tie to outdoor experiences. Folk stories often mix natural history and culture with creative storylines. You can have students write their own folk stories and read them to the class or analyze traditional folk stories from their own culture.



The second activity focuses on global climate change and includes two reading selections, each written from a different point of view. In this activity, students have an opportunity to compare and contrast, explore biases, and understand the complexity of environmental issues. The third example is an article on journal keeping written by environmental educator Bill Hammond. It provides ideas about how to incorporate "journaling" into your environmental education program and some tips and tricks for keeping a journal.

The short article focusing on Cubatao is an example of how to use an environmental issue to help students improve reading comprehension skills. The sample quotes are from a variety of nature and science writers. You can use quotes like this to help students analyze writers, compare and contrast writing styles, and look at how different people describe the environment. For example, you might have students compare these quotes to those from other countries and look at how different people view the environment. (You can also use the other quotes scattered throughout this book.)

The last two examples will give you ideas about how to use stories to get across important environmental concepts and ideas. The first is a story that focuses on health and environment and the second is a story about energy written by science writer Isaac Asimov.

ACTIVITIES IN THIS SECTION

1. **FOLK STORIES**

   Why the Crocodiles Were Not Killed, adapted by Hindowah Kamara.

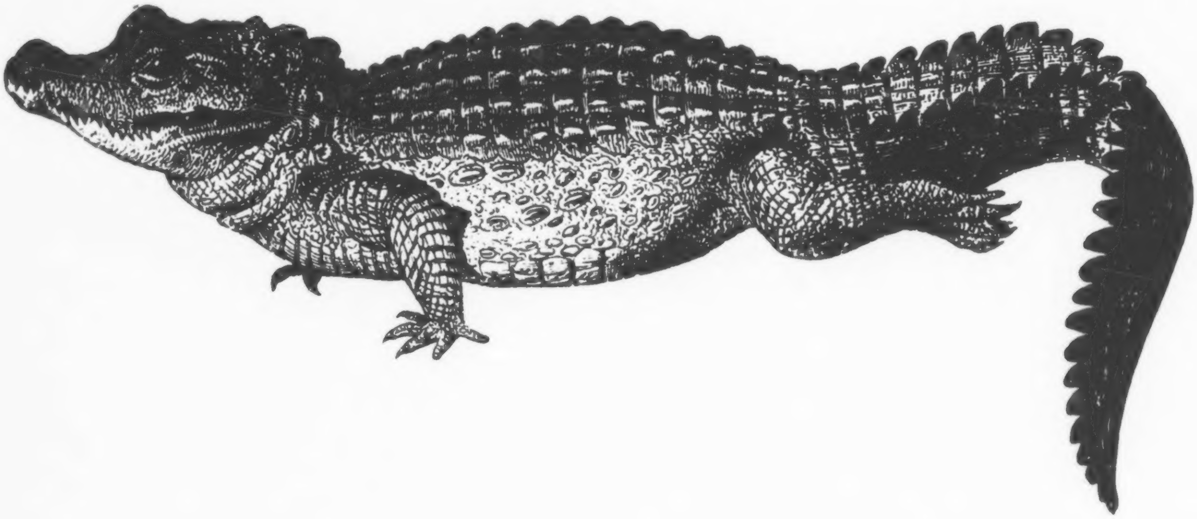
   The Cricket Story, adapted by Rona Leventhol in *Spinning Tales Weaving Hope, published by New Society Publishers (1992).*
2. **SELECTED QUOTES** from a variety of nature writers.
3. **A HEATED CONTROVERSY**, reprinted *from Ranger Rick's NatureScope: Pollution—Problems and Solutions* published by the National Wildlife Federation (1990).
4. **AN ENVIRONMENTAL EDUCATION TOOL . . . THE CREATIVE JOURNAL**, by Bill Hammond. Reprinted with permission from *Clearing,* a newsletter highlighting environmental education activities in the Northwest. *Clearing* is a publication of the Environmental Education Project at the John Inskeep Environmental Learning Center, 19600 S. Molalla Ave., Oregon City, OR 97045.
5. **CUBATAO: NEW LIFE IN THE VALLEY OF DEATH**, reprinted with permission the *Teacher's Guide to World Resources 1990-91* (World Resources Institute).
6. **CLEAN WATER FOR ELEMIT—A LETTER FROM THE VILLAGE HEALTH WORKER**, reprinted from *Clean Water—A Right for All* produced by UNICEF-UK, 55 Lincoln's Inn Fields, London WC2A 3NB England, and published by the Richmond Publishing Company (Copyright UNICEF-UK 1989).
7. **LIFE WITHOUT OIL,** reprinted from "The Nightmare Life Without Fuel," TIME (April 25, 1977, p. 33).

WHY THE CROCODILES WERE NOT KILLED

By Hindowah Kamara

Our great grandfather who built Kambama was called Fahguie. In those days, Kambama village was a very big village with many people. The great grandfather, Fahguie, was afraid for his people, the fishermen and bamboo trappers who roamed on the Moa River, that the crocodile would catch them and eat them. Because of this, Great Grandpa Fahguie thought of an idea. He sent for a Kamokoh (a Moslem man who made charm rituals), and he told the Kamokoh to work for him by praying to God to prevent the crocodiles from killing his people. This Kamokoh did the work by giving an order to the villagers to catch a crocodile. When the villagers caught the crocodile, Kamokoh put some ritual charms into the mouth of the crocodile and bound it with a red cloth and let it go. God answered his prayers, and a law was passed that no one born of Kambama should kill a crocodile or eat it. From that day onwards, crocodiles never disturbed anybody in Kambama. The villagers and the crocodiles all became one family.

Of late, the Government sent people from Mali to kill crocodiles because the Mali people were in need of skins. From that time on, the people of Kambama started to eat crocodiles.



THE CRICKET STORY

Adapted by Rona Leventhal

One day, when I lived in the city, I was going to eat with a friend. It was lunch hour, and we were walking down one of the busiest streets. There was all sorts of noise in the city . . . cars were honking their horns, you could hear feet shuffling and people talking! And amid all of this noise, my friend turned to me and said, "I hear a cricket."

"No way," I said. "You couldn't possibly hear a cricket with all of this noise. You must be imagining it. Besides, I've never seen a cricket in the city."

"No really—I do hear a cricket. I'll show you." My friend stopped for a moment, then took me across the street, and found a big cement planter with a tree in it. And there beneath the leaves there was a cricket!

"That's amazing!" I said. "You must have super-human hearing. What's your secret?"

"No, my hearing is just the same as yours. There's no secret—really. Watch, I'll show you." She reached into her pocket, and pulled out some loose change, and threw it on the sidewalk. And amid all the noise of the city, every head within twenty feet turned to see where the sound of money was coming from.

"See," she said, "it's all a matter of what you're listening for."

Rona Leventhal is a storyteller, writer, performer, and environmental educator from Massachusetts who conducts workshops throughout North America.

FOLLOW-UP ACTIVITIES FOR “THE CRICKET STORY”

RECOMMENDATIONS FOR TELLING THE STORY

I have found that this story is best told in the first person, although it can be told in the third person (i.e., “One day two friends were walking down one of the busiest streets in the city”). The story as I originally heard it used a Native American as the wise friend.

I usually include some audience participation by dividing the listeners into three sections: one group makes noisy car sounds, one group makes noises like people talking, and one group makes feet-shuffling noises. During the telling, when the first group hears me say, “Cars were honking their horns,” the first group makes their noise, and so on.

I have used the following activities both in residential environmental education work as well as on public school grounds. They include both indoor and outdoor activities, and can be done with approximately ten to twenty-five students. Most can be adapted to either rural or urban settings.

SENSORY AWARENESS ACTIVITIES

The story speaks to the need for us to be more aware of our surrounding environment, whether in the woods or in the city. Below are some activities that use our various senses to heighten awareness.

STALKING

This activity addresses several areas: listening awareness, sound localization, and predator/prey relationships.

- Participants stand in a circle.
- One person sits blindfolded in the middle of the circle, and a stick is placed approximately six inches away, to his/her side. S/he can’t hold or grab the stick at any time.
- When everyone is ready, the leader selects someone in the circle to be the stalker (by pointing or tapping on the shoulder) and says, “Someone is coming.” The stalker’s goal is to get the stick and get back to the circle without getting caught.
- The person in the middle “catches” the stalker by pointing at them. The teacher responds to the pointing with either “yes” or “no.” Let several stalkers try before switching the middle person.

Notes on facilitating this activityÚ As the judge, you need to decide the accuracy of the pointing. Some children try to point all over the place at once. Explain that the blindfolded person should only point if s/he thinks s/he has detected the stalker. You might need to add a rule limiting the number of times the blindfolded person can point.

Because the blindfolded person is depending on the sense of hearing to determine where the stalker is, the people in the circle should be instructed to keep their feet still, and be totally quiet.

This can be played on gravel or in a wooded area with leaf litter to make it more challenging. It is interesting to try it on different terrain, such as grass or cement, as a comparison.

Between rounds of the game, it is worth taking a moment to discuss the methods different stalkers tried in order to avoid being heard, comparing them to the ways real animals behave in the wild. (Keep in mind that in nature, the predator can also become prey.) If no one has tried a technique that you would like to illustrate, take a turn or two yourself as a stalker. Different stalking methods include going very slowly (like cats), stopping if you've been heard (like rabbits and deer), going very fast, distracting the prey (throw pebbles), and walking on padded feet (taking shoes off).

Visual Cues

- Participants stand in two lines, facing each other. Arrange the lines so that each person is standing across from another; they will be partners.
- At a signal, both lines turn their backs to each other. Each person changes three things about the way he or she looks. (You might use five things for older children). Discuss the idea that a subtle change, like removing a belt, rolling up a sleeve or putting your hair behind your ears, will be harder to guess (and therefore more fun) than a major change, like taking off a shoe or a jacket. Behavioral changes, such as crossing your legs, are not allowed.
- At the leader's signal, the lines turn to face each other again. One at a time, each partner tries to guess which things the other person changed. It helps to designate one of the lines to be the first to guess what their partners have changed.

Notes on facilitating this activity: It is a good idea, especially with young children (first and second graders), to quickly demonstrate this activity as part of the instructions.

This is a good activity to do before going out for a nature walk. At the end of the activity, I like to briefly explain that we often are not aware of details around us, both natural and non-natural. I encourage them to really notice things around them on the walk, or any time they are outside.

COLORFUL OBSERVATIONS

While on a nature walk, there are several trail activities to focus children on things they might otherwise not notice. Below are several ideas:

A. Give each student a color card. These can be either small pieces of construction paper, or samples from a fabric or wallpaper store. Instruct each student to find something in nature that has a similar color. Encourage them to think expansively. For instance, a blue color in winter could be the sky, or a yellow could be a shade of tan on a winter tree bud.

B. Give each child a card—or tell each child secretly—something you want them to find on the trail. These should be things that expand the way that they look at things in nature. For instance, you might ask a child to find:

- *something that is as old as s/he is*
- *something that is fuzzy or furry when you look closely*
- *something that is slimy*
- *three shades of the same color*
- *evidence of an animal*
- *three things in pairs*
- *something that looks lonesome*
- *something that smells good*
- *or something with the texture of sandpaper.*

HUMAN CAMERA

This activity is best done outside.

- Students need to be in pairs. All pairs start at a centralized location. One will be blindfolded, the other sighted (the leader).
- The leader *gently* directs his/her partner to any spot outside (it doesn't have to be far away from the class meeting place) so that their partner is looking very closely at something (e.g., bark, grass, a flower, a fern). When they are situated, have them lift their blindfolds for five seconds—just long enough to get a quick, close look at something (like a camera shutter). You might want to go on a longer walk and take several "snap shots" as you go.
- The leader then takes the blindfolded person back to the starting point, where the blindfold can be removed. The "camera people" can then discuss, draw, and/or write a description or a fanciful story about what they saw.

SELECTED QUOTES

The frog does not drink up the pond in which he lives.

—*Indian Proverb*

This we know. The earth does not belong to man; man belongs to the earth. This we know. All things are connected like the blood which unites one family. All things are connected. Whatever befalls the earth, befalls the sons of the earth. Man did not weave the web of life; he is merely a strand in it. Whatever he does to the web, he does to himself.

—*Chief Seattle*

When we try to pick out something by itself, we find it hitched to everything else in the universe.

—*John Muir*

We need the tonic of wildness—to wade sometimes in marshes where the bittern and the meadow-hen lurk, and hear the booming of the snipe; to smell the whispering sedge where only some wilder and more solitary fowl builds her nest, and the mink crawls with its belly close to the ground. At the same time that we are earnest to explore and learn all things, we require that all things be mysterious and unexplorable, that land and sea be infinitely wild, unsurveyed and unfathomed by us because unfathomable. We can never have enough of nature. We must be refreshed by the sight of inexhaustible vigor, vast and titanic features, the sea-coast with its wrecks, the wilderness with its living and its decaying trees, the thunder-cloud, and the rain which lasts three weeks and produces freshets. We need to witness our own limits transgressed, and some life pasturing freely where we never wander.

—*Henry David Thoreau, Walden*

Man always kills the things he loves, and so we the pioneers have killed our wilderness. Some say we had to. Be that as it may, I am glad I shall never be young without wild country to be young in. Of what avail are forty freedoms without a blank spot on the map?

—*Aldo Leopold*

The environmental crisis is an outward manifestation of a crisis of mind and spirit. There could be no greater misconception of its meaning than to believe it to be concerned only with endangered wildlife, human-made ugliness, and pollution. These are part of it, but more importantly, the crisis is concerned with the kind of creatures we are and what we must become in order to survive.

—*Lynton K. Caldwell*

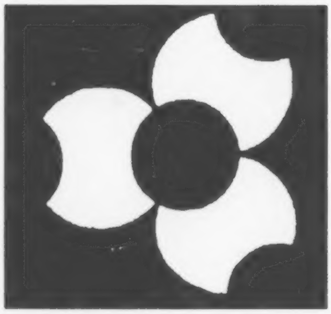
There is a great deal of talk these days about saving the environment. We must, for the environment sustains our bodies. But as humans we also require support for our spirits, and this is what certain kinds of places provide. The catalyst that converts any physical location—any environment if you will—into a place, is the process of experiencing it deeply. A place is a piece of the whole environment that has been claimed by feelings. Viewed simply as a life-support system, the earth is an environment. Viewed as a resource that sustains our humanity, the earth is a collection of places. We never speak, for example, of an environment we have never known; it is always places we have known—and recall. We are homesick for places, we are reminded of places, it is the sounds and smells and sights of places which haunt us and against which we often measure our present.

—Alan Gussow

There is a common thread that links these scenes and memories—the spectacle of life in all its varied manifestations as it has appeared, evolved, and sometimes died out. Underlying the beauty of the spectacle there is meaning and significance. It is the elusiveness of that meaning that haunts us, that sends us again and again into the natural world where the key to the riddle is hidden. It sends us back to the edge of the sea, where the drama of life played its first scene on earth and perhaps even its prelude; where the forces of evolution are at work today, as they have been since the appearance of what we know as life; and where the spectacle of living creatures faced by the cosmic realities of their world is crystal clear.

—Rachel Carson, The Edge of the Sea

Wilderness is the element in which we live encased in civilization, as a mollusk lives in his shell in the sea. It is a wilderness that is beautiful, dangerous, abundant, oblivious of us, mysterious, never to be conquered or controlled or second-guessed, or known more than a little. It is a wilderness that for most of us most of the time is kept out of sight, camouflaged, by the edifices and the busyness and the bothers of human society.



And so, coming here, what I have done is strip away the human facade that usually stands between man and the universe, and I see more clearly where I am. What I am able to ignore much of the time, but find undeniable here, is that all wildernesses are one: there is a profound joining between this wild cream deep in one of the folds of my native country and the tropical jungles, the tundras of the north, the oceans and the deserts, alone here, among the rocks and the trees, I see that I am alone also among the stars. A stranger here, unfamiliar with my surroundings, I am aware also that I know only in the most relative terms my whereabouts within the black reaches of the universe. And because the natural processes are here so little qualified by anything human, this fragment of the wilderness is also joined to other times, there flow over it a nonhuman time to be told by the growth and death of the forest and the wearing of the stream. I feel drawing out beyond my comprehension perspectives from which the growth and death of a large poplar would seem as continuous and sudden as the raising and lowering of a man's hand, from which men's history in the world, their brief clearing of the ground, will seem no more than the opening and shutting of an eye.

—Wendell Berry, An Entrance to the Woods

It is inconceivable to me that an ethical relation to land can exist without love, respect, and admiration for land, and a high regard for its value. By value, I of course mean something far broader than mere economic value; I mean value in the philosophical sense.

—Aldo Leopold, A Sand County Almanac

We are confident that the nature of the physical world permits continued improvement in humankind's economic lot in the long run, indefinitely. Of course, there are always newly arising local problems, shortages, and pollutions, due to climate or to increased populations and income. Sometimes temporary large-scale problems arise. But the nature of the world's physical conditions and the resilience in a well-functioning economic and social system enable us to overcome such problems, and the solutions usually leave us better off than if the problem had never arisen; that is the great lesson to be learned from human history.

—Julian Simon

For more quotes about the environment, see *A Dictionary of Environmental Quotations* compiled by Barbara K. Rodes and Rice Odell (Simon and Schuster, 1992).

A HEATED CONTROVERSY

OBJECTIVES:
Discuss the causes and possible effects of global climate change. Explain why it's important for individuals to be aware of current issues in science.

AGES:
Intermediate

SUBJECTS:
Science, social studies, language arts

MATERIALS:
Copies of the positions of Scientist 1 and Scientist 2.

By reading two articles about global climate change, your kids can learn more about how some air pollutants may be affecting our climate. Begin by asking the kids to tell you what they know about climate change, often referred to as "global warming." Then use the background information in the *NatureScope: Pollution—Problems and Solutions* issue to talk about the greenhouse effect and greenhouse gases, such as carbon dioxide and CFCs (see the Bibliography for resource listings).

Next, explain that although most scientists agree that the increasing amounts of carbon dioxide, CFCs, methane, and other greenhouse gases in the atmosphere will affect the world's climate, there's some disagreement about whether these changes have already begun and how serious the effects will be. Scientists also disagree on how we should react to global climate change.

Now pass out paper and copies of the scientists' statements on pages 170-171 to each person and explain that each of these articles expresses a point of view about global climate change. (Neither article was written by a real scientist, but both points of view have been expressed by people in the scientific community.) Give the kids time to read the articles and answer the questions that follow the second one. Afterward discuss the kids' answers using the information under "Is the Heat Really On?" and "A Look at the Facts." Finish up by having the kids brainstorm some ways that they can help reduce the amount of greenhouse gases that are being released into the atmosphere (bike, walk, carpool, or take public transportation whenever possible and encourage friends and family to do the same; conserve electricity and buy energy-efficient appliances; don't buy products made with CFCs; encourage parents to have car air conditioners serviced at stations that can recycle coolant made with CFCs and to have home and car air conditioners checked for leaks).

IS THE HEAT REALLY ON?

1. Scientist 1 thinks that global warming is already underway and we need to cut carbon dioxide and CFC emissions now to slow it. Scientist 2 believes that we can't be sure yet if the world's climate is warming as a result of increased CFC and carbon dioxide levels and that we need to do more research before we take any drastic action.

2. **ADVANTAGES:** would help cut down on the possibility of causing further global warming; would cut down on pollution in general due to decreasing use of fossil fuels, increasing energy efficiency, and switching to alternative energy; would save money due to use of more energy-efficient appliances.

   DISADVANTAGES: would cost more in the short run to develop more energy-efficient cars, factories, and appliances; might eliminate some jobs or cut profits.

3. **Advantages:** would result in more knowledge about our atmosphere; would cost less in the short term; would not inflict hardships on U.S. businesses and people in developing countries.

   Disadvantages: would not reduce pollution; would cost more in the long run; would increase the likelihood that, later on, it might be too late to stop the warming trend. (*Note: Point out that the costs associated with either scientist's recommendation are difficult to estimate.*)

4. A possible compromise could include making some of the changes suggested by Scientist 1 to help increase energy conservation, while continuing to do research as Scientist 2 advocated. Some scientist and policymakers support this strategy to slow the potential warming trend without threatening to harm the economies of the U.S. and other countries.

5. Opinions will vary. Point out that decisions about global climate change, like decisions about many complicated environmental issues, are often based on information that may or may not be as complete as people would like. People's values also influence their decisions.

6. It's important to stay informed about scientific issues so that you can better understand problems and can change your daily behaviors to help solve problems. For example, consumers can avoid buying products that contribute to the buildup of greenhouse gases, if they know what the problems associated with these gases are and how their actions contribute to the problems. And people can write to their representatives to encourage them to support environmental legislation.

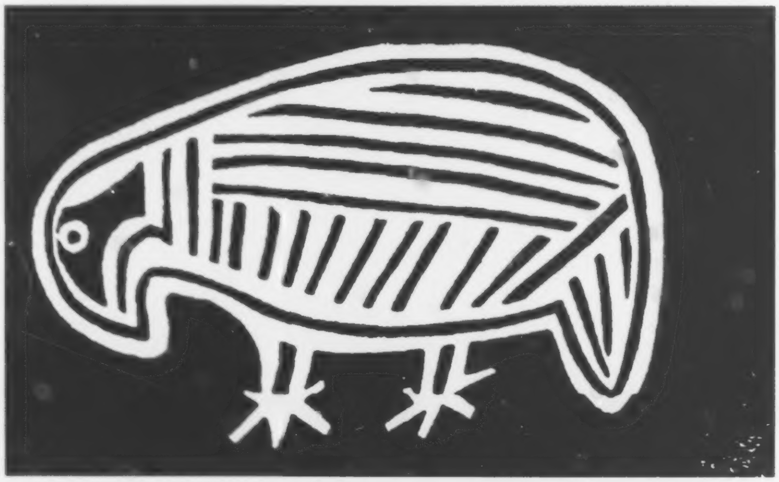
A Look at the Facts

- Overall, average world temperatures have risen about 1°F over the past century. But this hasn't been a constant rise. Between 1940 and 1970, average temperatures dropped.
- Developing countries are expected to rapidly increase their carbon dioxide emissions in the next 20 years, as their populations increase and they acquire fossil fuel-burning technologies.
- Cuts in carbon dioxide and CFC emissions must be made worldwide to be effective. The U.S. and other developed countries have agreed to supply developing countries with technology and funds to help them replace CFCs.
- Most scientists agree that the increase of greenhouse gases will affect the world's climate. But they're unsure about when these changes will start (if they haven't already), how much the world will warm up or cool down, what specific regions will be affected, and how rapidly the changes will take place.

- Some experts say it will take decades of research before they can be sure if the earth's climate is warming up. Others feel that we have enough evidence now.

QUESTIONS

1. What are the main points brought up by each scientist?
2. What are the advantages and disadvantages of the alternative presented by Scientist 1?
3. What are the advantages and disadvantages of the alternative presented by Scientist 2?
4. Can you think of a course of action that is a compromise between the two plans presented by the scientists?
5. What do you think is the best course of action? Why do you feel this is the best thing to do?
6. Do you think it's important to stay informed about scientific issues? Why or why not? What are some ways you can affect the decisions that politicians make about the environment?



A HEATED CONTROVERSY: PART 1

It's time to face the facts—the increasing amounts of carbon dioxide and CFCs in the atmosphere are making our planet's climate warm up. We've seen the warning signs in our increasing world temperatures. The 1980s were the hottest decade in recorded history—six of the warmest years ever recorded were 1981, 1983, 1986, 1987, 1988, and 1989. While this isn't proof that global warming has begun, it certainly should warn us that something is happening to our climate.

Over the past 100 years, average world temperatures have risen by about 1°F. That may not seem like much of an increase, but keep in mind that temperatures today are only about 9°F warmer than they were during the last ice age. It takes only a small change in temperature to cause big changes in our world. And if we continue to put as much carbon dioxide into the atmosphere as we're putting into it now, the world's average temperature may increase by 3 to 10°F within the next 50 years.

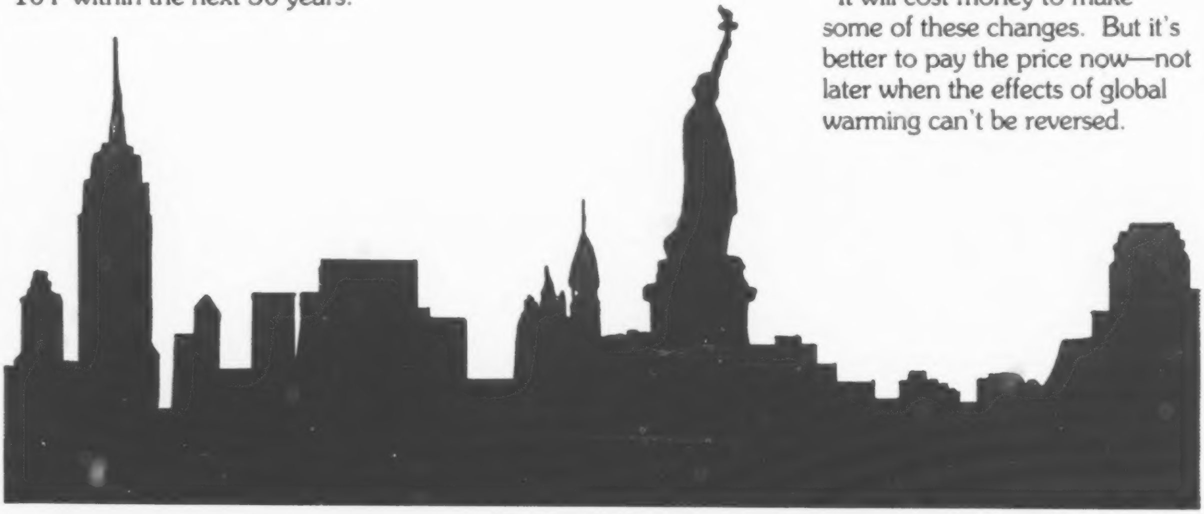
If temperatures do rise, we can expect some drastic changes to take place. As temperatures go up, sea levels will rise and many coastal areas will become flooded. The warming could make droughts occur more often in certain areas. Some places, like the Midwest, could become so hot and dry that many crops couldn't grow there anymore. And all over the world, plants and animals may not be able to adapt quickly enough to the sudden changes in their habitats. Some species could even become extinct.

Some people claim that we should wait until we're absolutely sure of global warming before we do anything to control it. I disagree. If we wait too long, it may be too late to prevent damage from the warming trend.

We must cut carbon dioxide production by at least 20 percent and phase out CFCs *now*. And since people in the United States produce a lot of the carbon dioxide and CFCs that go into the air, we have to set an example for the rest of the world. We must develop safer chemicals to replace CFCs. We have to switch to solar power and other alternative energy sources. And until we make that switch, we have to use less fossil fuel and become more energy efficient. Industries that continue to use coal and other fossil fuels should be taxed for the excessive carbon dioxide they release. A tax should also be placed on gasoline to encourage people to drive less. And car makers should be required by law to make cars that get better gas mileage.

Individuals must do their part too, by taking public transportation instead of driving their cars so much and by buying more energy-efficient appliances and cars. And we have to stop the burning of tropical rain forests. By preserving these forests, we can reduce carbon dioxide emissions caused by the burning *and* save the trees and other vegetation that help absorb carbon dioxide.

It will cost money to make some of these changes. But it's better to pay the price now—not later when the effects of global warming can't be reversed.



A HEATED CONTROVERSY: PART 2

SCIENTIST 2

There's been a lot of concern lately that the world's climate is warming up. Some scientists say that the increased amounts of carbon dioxide and CFCs in the atmosphere are causing this global warming. According to them, the only way to avoid global disaster is to cut carbon dioxide emissions by at least 20 percent—a move that would affect people all over the world.

I say there's not enough scientific evidence to back up this call for drastic action. Let's consider the facts. It is true that there's more carbon dioxide in our atmosphere than there used to be and that we have added gases, such as CFCs, that were never part of our atmosphere before. But there's just not enough evidence to prove that these gases are making the world warm up. In the past 100 years, average world temperatures have risen by only 1°F. And this hasn't been a constant rise—between 1940 and 1970, world temperatures actually dropped, and some scientists suggested that another ice age might be on the way. This latest rise could be just another small change in a natural climate cycle.

It's very important to keep in mind that many of the predictions about the effects of global warming are based on *theory*. Scientists have come up with these predictions by plugging information about our atmosphere into computers. The computers make predictions about what will happen if we add certain amounts of carbon dioxide and other gases. The problem is, different computer models can give you different answers! Some models have predicted that the increase in carbon dioxide will cause more clouds to form. These clouds would block sunlight and cancel out much of the warming. And, according to other models, it's possible that the earth's huge oceans will absorb any extra heat. We just don't know enough yet about how our atmosphere works.

Because of this uncertainty about what is really happening in our atmosphere, I believe we need to do more research before we make any big changes. To significantly cut the amount of carbon dioxide we put into the atmosphere would make life harder for many people—especially those living in less developed countries. How can we ask them to cut back on releasing carbon dioxide when they're just now getting the cars and factories that people in more developed countries have had for so long? And in the United States, cutting carbon dioxide production would cost billions of dollars each year. Forcing industries to stop using fossil fuels might drive some smaller firms out of business and hurt people in regions where coal mining provides many jobs. We must do more research before we make changes that, in the end, may cause more harm than good.

QUESTIONS

1. What are the main points brought up by each scientist?

2. What are the advantages and disadvantages of the alternative presented by Scientist 1?

3. What are the advantages and disadvantages of the alternative presented by Scientist 2?

4. Can you think of a course of action that is a compromise between the two plans presented by the scientists?

5. What do you think is the best course of action? Why do you feel this is the best thing to do?

6. Do you think it's important to stay informed about scientific issues? Why or why not? What are some ways you can affect the decisions that politicians and other leaders make about the environment?

An Environmental Education Tool

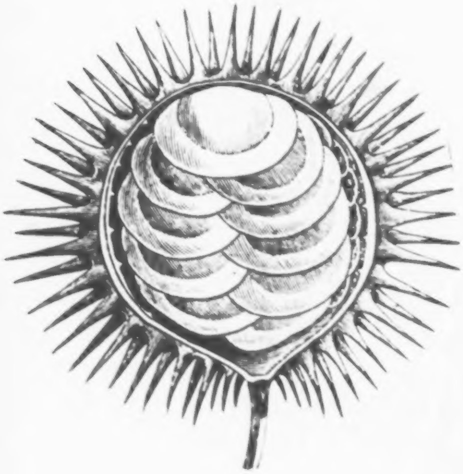
THE CREATIVE JOURNAL

By Bill Hammond
Lee County School District, Fort Myer, Florida

Writers live twice.
—Natalie Goldberg

There are few naturalists that do not use a journal as a working tool. Darwin, Thoreau, Burroughs, Muir, Audubon, Seton, and Carson all used the journal to gather their observations and insights into the nature of the universe.

In today's environmental education programs the creative journal can be a very powerful instructional tool. So many of our students are conditioned to either passive participation and being entertained or to being "hyper" participants that rarely have the guided opportunity to become a careful observer, who can reflectively access or communicate what they feel, value, or believe about how the natural world works.



In environmental education students need an opportunity to slow down and "see," "feel," and "know" what they are experiencing. They blossom when given opportunities to draw, paint, paste in, write, or otherwise collect and access what they feel and know about what they are experiencing. Journaling provides a chance for participants to dig in below the surface mirror to explore their inner values and beliefs. By balancing writing and imaging they engage all brain modes of cooperation. By learning to draw they must learn to see. As "seeing" improves, so do drawing skills grow and students are further empowered.

Just as humans co-evolved with tools; creative journals are a powerful tool to support people engaging in environmental education programs.

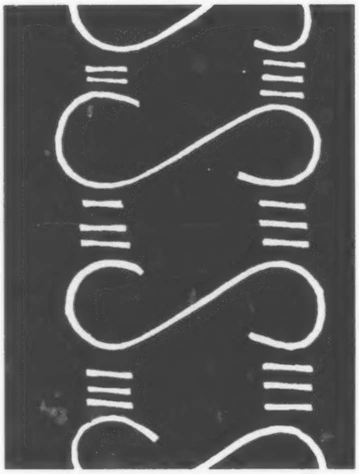
Some people prefer to keep a diary, others a field notebook of observations and some a creative journal. All have value. Getting started, then bonding to the book and the experience on a regular basis are the elements of a successful experience. The accompanying article gives some insight to a rationale and process for making journaling a regular component of your environmental education experience. When you're away from your journal for awhile and it "calls" you . . . you'll know that you have bonded the tool with your creative self and your reflective needs. Best wishes as you explore the environment we share and transfer nature from experience to your brain/mind system to your journal pages.

Strange as it many seem in this era of high technology, the use of a personal journal is re-emerging as one of the most powerful of today's tools. It speaks to the need for "high touch"—and is available to help support an expanding quest for personal as well as organizational and corporate creativity.

The type of journal that is being rediscovered by so many people is not generally a diary—which is a different type of potentially powerful personal history, and often a therapeutic tool—but rather a creative tool. Today's journal is one that, by its format and nature, serves as a nesting place for creative insights and ideas. It is a journal that becomes a place and a medium to serve as a mental and physical playground full of images and text. It connects the journalist to the nature of life on the planet. It provides a context for exploring pertinent and functional ideas in progress. Virtually every system for creative thinking requires some type of idea-catching system. However, the type of creative journal I describe is far more than just a book for catching the "aha!" of the moment. It becomes a place to generate, expand, explore, and document ideas and mental excursions—while they are in progress.

How do you get started? Do you work in your journal every day? These are usually the first questions asked by folks toying with the idea of doing the journal.

For me, early attempts at diaries or logs on camping trips and, later, field research journals and notebooks, were a beginning—but they were a rather spasmodic endeavor. Then friend and mentor Bob Samples introduced me to the concept of keeping a "creative journal" in order to better catch our ideas in play and progress. Bob develops many of his books from the ideas and insights first explored in the pages of his journals. Later, Ned Herrmann, then Director of Training for General Electric and now President of Applied Creative Services, asked me to develop a session on journal keeping as part of his week-long Applied Creative Thinking Seminar program. Since then I have introduced thousands of people—ages three to 94—to creative journal keeping. These are students, parents, educators, corporate executives, friends, and grandchildren who are now experiencing the pleasures of growth that flow from the sense of satisfaction and accomplishment derived from seeing one's own insights, creativity, and wisdom captured on a journal page of image and text.



All it takes to get started is a book with lined, unlined, or graph pages—whatever best suits you. You also need some inexpensive tools for writing, drawing, coloring, painting, cutting, and pasting. A gluestick is terrific! Clear plastic adhesive cut to your journal's page size is useful for sealing things like leaves or items for collages into your journal's pages. You also need a commitment to work on analyzing, imaging, reflecting, risking, and synthesizing.

I find it helpful for each of us to establish our own rules for journal keeping. To establish rules, you must think through your purposes for keeping a creative journal. For me, the purposes for keeping a journal are to enhance my creative insights; to get below the surface to seeing things in life; to reflect on the wisdom of nature; and to improve my ability to recognize and express my feelings and emotions about things I value. I want to improve my flexibility and fluency in thinking and expressing ideas. To accomplish this, I make rules for my journal keeping, such as: I can't use the same medium—for example, a pen—to write for more than three consecutive pages in the journal. When we change the medium, color, and layout, we tend to change the ways in which we think. This is a way to encourage our own flexibility—a necessary ingredient for creativity.

In order to stay fluent—as well as anxious to produce volumes of completed pages in my journal—I imprint myself on each journal much as a hatching sea turtle does to a specific beach; a bird or a child to its parent; or a salmon to its hatching stream. This technique is simple but powerful, in that it begins each journal in a unique way. My imprinting occurs on the first two pages.

When beginning a new journal, I sit quietly and absorb my location. On the left page, I create a color image in some fashion. The image may be abstract or realistic. It is something specific about the time and place—and reflects some insights that flow from the nature around me. I may be in the mountains, at a beach, in the city, or in my yard at home—it can be anywhere outside that takes on a special meaning to me.

On the right hand page, I write in a stream of consciousness mode. I record what flows from my mind at that time and place.

The journal then becomes the journal of that place or time. Somehow this bonding process with a journal—especially if reinforced by rapidly generating the first dozen pages or so of new ideas, information, and reflections—tends to develop a connection and commitment to the journal that stimulates even those with more apathetic and procrastinating tendencies. Each person should develop his or her own style and pattern for frequency of journal use. For some it may be an almost daily endeavor. For others, it is an effort that takes periods of intense journal productivity, followed by journal aestivations or even hibernations. In any case, if you have effectively imprinted and worked on the first 10 pages or so of your journal, it is difficult not to return to it. It has its own way of calling you.

It is that first ten pages or so of the journal that most people have a difficult time creating. The threat of the blank page is sometimes overwhelming, as is an ego compulsion that every page must be a masterpiece. Through the process of offering journal workshops, I have compiled more than 100 "starters" for journal assignments. Some are as simple as outlining an object such as coins from your purse or pocket—or tracing a carefully selected leaf and then writing your insights either inside or outside the outline patterns. A favorite of many people is one dubbed the "daily double." Select a place, object, or event to carefully observe. Label the right page of a page pair, "observations." Label the left page, "reflections." On the observations page, record all the pertinent observations in the best scientific style that you can make. Describe context, physical characteristics, time sequences, interactions, temperature, air flow, quantifiable points of interest—details, details, details!

On the reflections page, record your inner perceptions, insights, and feelings—as well as your sense of connection or distance from the place, object, or event. In the first case, you are gathering data observed outside yourself. In the second part of the exercise, you are gathering data from inside yourself. Both are powerful sources that shape your sense of attention to, and ways of knowing, something. Research on the human brain validates both of these means of perception as being equally valuable in accessing your perceptions and processing your relationships to the environment. Practice with this exercise will sharpen your perceptions and abilities to observe—and will also stimulate your potential creative connections. Creating "art works" in your journal is vital to developing these same skills. Often people say, "I can't draw." Actually, drawing is linked to seeing. The better you see, the better you draw; the better you draw, the better you see. Drawing and "seeing" both improve with practice. You are building eye-hand-brain/mind connections. As these skills improve through use, so will your creativity.

There are many sources and references for helping you maintain momentum and interest in your journal. Some are listed at the end of this article. Beyond the formulation of your own goals and rules for journal keeping, I would also suggest the following simple and general guidelines for journal keeping.

1. **Make the Journal a Place of celebration—A Fun place to Work.** Make only positive entries. If your urge is to record the negative, turn it around by capturing the positive attributes and outcomes gained from the negative tendencies. If you are against something, you must be for something. Catch and record your wishes—and what you truly want to see.

2. **Strive to Create a Balance of Images.** Sketches, paintings, pasted-in pictures, photos, postcards, collages, or objects captured under clear sheets of adhesive plastic can all be included—as well as numbers and words as expressions of your insights. Balance is the key. Ideally, I think every picture needs some textual insight, every text needs an accompanying image. This is important in order to recognize and expand your whole-brained ways of knowing.

3. **Take Risks. This is Your Journal.** Try colors—for example, the two ugliest, the two most outrageous—and use them. Experiment with different mediums—colored pens, pencils, watercolors, and rapidiograph pens. Be flexible and experiment. Stretching yourself is a key to unlocking your personal creativity.

4. **Work from Back to Front!** Use the back of your journal as a filing place to capture pertinent trivia, paste in business cards, etc. Working your journal pages from the front to the back of the journal book is a way to record your creative insights, new ideas, or images and text about newly acquired information. It is a place for the inevitable quotes you would like to remember. Simultaneously, take all your daily

notes from meetings, seminars, phone calls, etc., and record them from the back to the front of your journal. Often it is appropriate to extract ideas, insights, and your own restatements of what you think is important from these back-of-the-book repositories. You can transform them into conceptual or emotional expressions of insight in the front section of your journal This strategy offers several powerful advantages:

- It gives you a reason for always having your journal with you—for note taking and more;
- It helps to assure you will "fill" journals in a reasonable time, providing a sense of accomplishment and closure;
- It provides time for artistic reflection that results in a more thoughtful, more finished front section; and
- It gives permission for the rear section to be quickly done, without perfectionism and neatness being limiting criteria.

Using the journal as a tool to nurture the growth of personal creativity and connectedness to the living planet can be a powerfully enriching experience for nearly any age person—from the very young to the long-living.

For the very young, observing and experiencing nature as well as expressing feelings can be enhanced with the journal. It serves as a place for artistic expression and documents facets of growth. My grandchildren began their own journals—on their own initiative—at three or four years old. They are now amazed at their early work when they look back at it through the "grown" eyes of six and seven year olds. They are each well into their third hardbound volumes. Having to learn to discover and mix the "magic colors" from a paintbox that has only primary colors and black—and to gather artifacts and images from trips to the backyard, swamps, forests, and beaches—tells a tale of growth, risk, and more growth. They are able to recall aspects of their life and growth from the powerful sources of their own authorship—instead of relying only on images from worn-out "refrigerator art."

As is true of so many of our south Florida citizens, my dad's journal is just beginning—at age 73—as he puts together a history of a family heritage.

Journal mentorship is helpful. Voluntary journal-sharing sessions among family and friends can be rich and motivating. The key is to begin. If several people can share their journal insights periodically, so much the better for motivation.

The journal is an empowering tool for enhancing personal creativity. It is a place to catch insights—to nature, the living planet, one's self, and others. It becomes a record of risk, growth, and new insights. It is a place to express your personal ways of knowing. It is a whole-brained approach to accessing feelings and intellect about things that matter. Literate cultures have used writing to separate the known from its context for more than 2000 years. The creative journal can be a medium to moderate the limiting impacts of literacy on thinking—while supporting and expanding the gifts of literacy. Images, artifacts, color, emotion, and ritual are some of the tools of the whole brain that find a new medium within a creative journal. The journal keeper is empowered. Through a sense of empowerment comes a willingness to take informed risks and to grow. In this way, creative growth is nurtured within the human spirit. It is a fascinating journey. Why not find a blank book—and take the first steps to come along?

RESOURCES

Drawing on the Right Side of the Brain by Betty Edwards (J.P. Tarcher, Inc., 1979)

Mind Sight: Learning through Imaging by Beverly-Colleene Galyean (Center for Integrative Learning, 1982)

Thinking Visually by Robert McKim (Wadsworth, Inc., 1980)

Writing the Nature Way by Gabrielle Rico (J.P. Tarcher, Inc., 1983)

Open Mind, Whole Mind: Parenting and Teaching Tomorrow's Children Today by Bob Samples (Jalmar Press, 1987)

Bill Hammond is an outstanding educator and naturalist. He can be reached for additional information at the Lee County Schools, Environmental Education and Instructional Development Services, 2055 Central Avenue, Fort Myers, Florida 33901.

CUBATAO: NEW LIFE IN THE VALLEY OF DEATH

Called the "Valley of Death" and the "most polluted place on earth," Cubatao—located on the Atlantic underbelly of Brazil's industrial potentate, Sao Paulo—had a reputation that no city would want to claim.

Before the 1970's, Cubatao might have been considered a pleasant, well-situated town, looking upon the bay, with tree-covered mountain slopes rising on three sides around it. The valley where the town is located was traversed by rivers that flowed into the sea, lined with mangroves.

When a river was first dammed up to generate energy, industries began to crowd into this town near the major port of Santos. A steel plant, a huge oil refinery, and fertilizer and chemical producers squeezed into the valley, while workers and job seekers set up shacks on swamplands and hillsides around the industrial nucleus. By 1985, Cubatao was producing 3 percent of Brazil's gross national product.

By then, the mangroves were gone, the waters were the color of mud, and silt backed up in the rivers, which overflowed regularly. The changes in the rivers also signaled the losses on the mountain slopes as the smog-filled air left trees like skeletons with threadbare leaves. Loss of vegetation led to erosion, and hillsides crumbled, collapsing around the town.

The 110,000 residents were under siege; poisonous wastes from industries were scattered around, dumped in the rivers, and pumped into the air where winter weather would trap the gases in the valley for long periods. Accidental spills and chemical accidents claimed hundreds of lives and led to emergency evacuations on a yearly basis.

This is no longer the situation. The town of Cubatao has changed, and today the state of Sao Paulo points with pride to the results of a cleanup effort that required industries to control pollutants. Out of 320 sources of pollution, 249 had been cleaned up and controlled by late 1988. Particulate pollution had been reduced 92 percent, ammonia was down by 97 percent, and the hydrocarbons that cause ozone were cut 78 percent. Sulfur dioxide levels fell by 84 percent, but nitrogen oxides dropped only 22 percent. No major emergencies from dangerous levels of air pollution were reported in 1987.

Water quality in the three main rivers of the valley has improved notably. The obvious sign is the return of fish, after a 30-year absence, to the Cubatao River. The industrial effluents being dumped into the rivers were cut from 64 metric tons each day to 6 metric tons, with corresponding reductions in the amounts of metal in the water. Parts of the rivers were also dredged of 780,000 cubic meters of material to improve the flow.

What did it take to restore the environment of Cubatao to livable levels? First came the restoration of democracy to Brazil, allowing complaints from residents in Cubatao to be publicized in the press. Gubernatorial candidate Franco Montoro made Cubatao an issue in his political campaign, then committed his government to reducing the pollution. During the Montoro administration from 1983 to 1987, the state worked with the private sector, sharing the costs of the cleanup. The state government's plan had an estimated cost of $98 million, and the total investment in pollution devices by industries was $220 million. The program was backed by a $100 million loan from the World Bank.

The government also launched a program to reforest the mountain slopes with pollution-resistant trees bred from species native to the area, to contain the erosion and mudslides that were threatening to bury the town. The Forestry and Botanical Institutes developed seed pellets that could be sown on the mountainsides from helicopters, and millions of seeds were spread over an area of 60 square kilometers.

The change in Cubatao is heartening, but not yet complete. The principal industry that is still polluting the valley is the government-owned steel plant, which has not been able to invest in pollution control because of the restrictions imposed on the government by the debt crisis.

Reprinted from World Resources Institute, United Nations Environment Programme, United Nations Development Programme, World Resources 1990-91 (Oxford University Press, New York, 1990).

QUESTIONS

1. Where is Cubatao located?
2. What was Cubatao like prior to 1970?
3. What industries settled in Cubatao? Why did they come?
4. How did the air in Cubatao become polluted?
5. How did the water become polluted?
6. Why was Cubatao called the "Valley of Death"?
7. Who led the cleanup campaign?
8. What steps were taken to deal with the pollution?
9. How much did the cleanup cost and who paid for it?
10. Can you name any place, in either your state or region, that is similar to Cubatao? What has caused the pollution? Has any progress been made in dealing with the pollution?

A Letter From the Village Health Worker

CLEAN WATER FOR ELEMIT

Filthy water cannot be washed.

—West African Proverb

The following article is reprinted from *Clean Water* (copyright UNICEF-UK 1989), and helps students understand the place and function of water in their own lives and in the lives of people in countries where a supply of clean water and good sanitation facilities are not always readily available.

Hello, my name is Dikeledi, and I live in a small village in the middle of the great dry plains of Masailand in Northern Kenya. It is a beautiful country and it is my home, but sometimes life is hard.

Among other things, clean water is very difficult to find. And even though the country is most often dry, there are times when the rain comes in such sudden cloud-bursts that it destroys our homes, and our few trees and precious top soil are scraped from the land.

I was born and brought up in Elemit, and I have wanted to stay since I can remember thinking about it. But I have wanted all our lives to be better. So, for a while, I went away to town and learned how to become a village health worker. I learned a lot about health and hygiene, about looking after small children who easily became ill with diarrhea and other nasty diseases.

Dirty water causes diseases and much suffering. This I knew, but I didn't know exactly how and what to do about it. If you asked the women of my village what they most needed they would all shout "CLEAN WATER!!" because they know what happens to the children when they drink from the water hole or from the old well. The women will tell you that from being young girls they have had to carry all the family's water on their heads and backs. They must do it because it's 'women's work', definitely not for men. It is hard work and it takes much of the day to complete, because the village well is 4 kilometers away from our homes.

How can I expect a young mother with a small baby to make extra journeys, so that she can have enough water to keep her baby as clean and free from possible infection as she wants? In my job I should find ways for all the women to benefit from my training for the sake of their health and for their children. It's hard to boil the drinking water and kill the bugs that live in it because the fire would need a lot of wood. Trees are very scarce around here.

All this we know. The question is how to change it. Our well isn't exactly clean. Children play in the mud, and the cattle come and drink from the pools that collect around the well. When we get there we gossip about neighbors, fill our buckets and enjoy the rest before the journey home. But now I worry. I can always see the tsetse fly hovering, and I know now how he gives us the sleeping sickness. He loves the damp, warm pools. I see the snail in the water that breeds the dreaded bilharzia, and I know that hookworms invade my body through my muddy feet, and they grow and move around inside me!

You see, there are many problems. I remember that in town someone said that there are water-bearing rocks near our village. I told the women of this, and since then we have had some meetings and formed ourselves into a committee for the improvement of our working lives (and of course for the younger girls too). The women set down the things they wanted to achieve.

We talked a lot about asking the government to help—and we talked to the men of the village also. Everyone in Elemit wants to solve the problems quickly, but we would have to wait a long time for the surveyors, engineers, drilling teams, and perhaps pumps to reach us out here in the bush. Ha! We agreed that if we all worked we could dig the well ourselves much quicker.

But I wanted to make sure the water stayed as clean as the day we found it underground. If you put a bucket down in the mud and then swing it down into the water, the parasites, hookworm, and other things float off into the water. They contaminate the water and before long it would be just as bad as it is now.

Two friends walked with me to town. We called to see the District Officer to talk about what we needed. He told us of a village quite near us that has a well with a special pump. Some days later a group of us went to have a look. We walked for two-and-a-half days. The land was hot and dusty, bone dry. The journey was worth it. The people fed us and we talked well into the night; firelight and good drink gave the faces a glow.

Anyhow, to cut a long story short, we looked at the well and the pump, and it was just right for us. So we made the journey home in high spirits and began to dig.

And, do you know, we found good, clean water about three metres down. We all believed that we could make and look after a pump like the one we had gone to see in the other village—a hose and bucket pump.

This is how it works. The water in the hose must be at the same level in the bucket. Then, if you raise the bucket above the outside bit of hose (discharge outlet), the water will run out!

In town we found a suitable length of hose and a smith soldered a short length of metal pipe into the bottom of the bucket. Just before we finished building the surrounding wall, one of the older women came and filled a bucket. But she left the hose in the bucket when she had filled it and then started to lower the hose bucket down into the well. What a fright she got! She thought an evil spirit was at work! We tried to explain the mystery. When you lower the bucket, the hose "sucks". I'm not sure she was convinced.

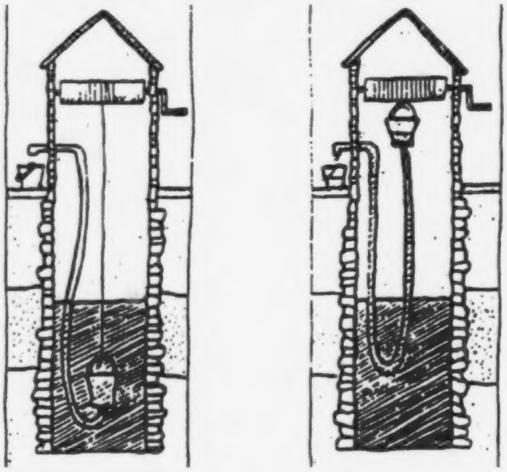
Anyhow, our 'engineering' answer to the problem was to fix the hose at the outlet so that it wouldn't drop into the bucket. Elemit Hose and Bucket Pump is still working after more than a year and we've only had to do minor repairs. The journey isn't so long and the water is clean. We are all more healthy, especially the babies. I'm very happy in my work. Life is good. If you come to Kenya, please come and visit us.

ACTIVITIES

- Find out about sleeping sickness, hookworm, and bilharzia—how these diseases spread, their effects, etc.
- Look at pictures of old wells. How many health problems can you see? How can you make the water from these wells safer to drink.
- Make a model of the hose and bucket pump in your classroom. Compare Elemit's old well with the village's new hose and bucket pump.

The previous article is reprinted from Clean Water, *produced by UNICEF-UK 55 Lincoln's Inn Fields, London WC2A 3NB England, and published by the Richmond Publishing Company, Ltd., PO Box 963, Slough, SL2 3RS England.*

THE HOSE AND BUCKET PUMP

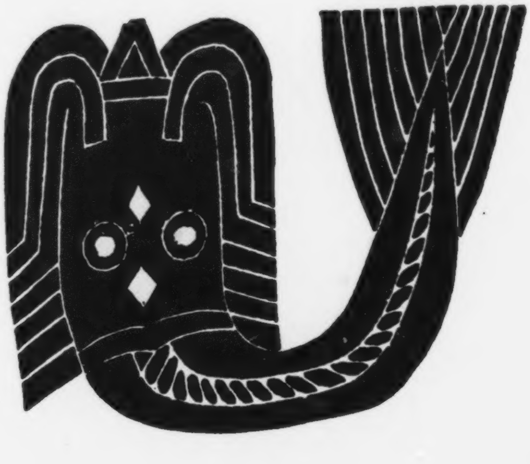


LIFE WITHOUT OIL

What would life be like without petroleum for fuel? *Time* magazine asked Isaac Asimov to describe such a world. Asimov chose the year 1997 as a target date. By 1997 you will be a part of the public responsible for helping make decisions and dealing with their consequences.

Here is an excerpt from Asimov's story:

> Anyone older than 10 can remember automobiles. They dwindled. At first the price of gasoline climbed—way up. Finally only the well-to-do drove, and that was too clear an indication that they were filthy rich, so any automobile that dared show itself on a city street was overturned and burned. Rationing was introduced to "equalize sacrifice," but every three months the ration was reduced. The cars just vanished and became part of the metal resource.
>
> There are many advantages, if you want to look for them. Our 1997 newspapers continually point them out. The air is cleaner and there seems to be fewer colds. Against most predictions, the crime rate has dropped. With the police car too expensive (and too easy a target), policemen are back on their beats. More important, the streets are full. Legs are king in the cities of 1997, and people walk far into the night. Even the parks are full, and there is mutual protection in crowds. . . .
>
> As for the winter—well, it is inconvenient to be cold, with most of what furnace fuel is allowed hoarded for the dawn; but sweaters are popular indoor wear and showers are not an everyday luxury. Lukewarm sponge baths will do, and if the air is not always very fragrant in the human vicinity, the automobile fumes are gone. . . .
>
> *Source: "The Nightmare Life Without Fuel," Time (April 25, 1977), p. 33.*



Petroleum Products

Ink
Heart valves
Parachutes
Stretch pants
Telephones
Brassieres
Enamel
Transparent Tape
Antiseptics
Vacuum bottles
Ping-pong paddles
Purses
Planters
Deodorant
Air conditioners
Crayons
Dolls
Bubble gum
Floor polish
Sports car bodies
Tennis balls
Tires
Carpet sweepers
Shower doors
Soap dishes
Slip covers
Shoes
Volleyballs
Tobacco pouches
Refrigerator linings
Electrician's tape
Model cars
Folding doors
Floor wax
Mascara
Sweaters
Sneakers
Electric blankets
Tennis rackets
Drinking cups
Housepaint
Rollerskate wheels
Hair dryers
Guitar strings
Ammonia
Eyeglasses
Digital clocks
Life jackets
TV cabinets
Car battery cases
Insect repellent
Ice buckets
Fertilizers
Hair coloring
Toilet seats
Denture adhesives
Frisbees
Loudspeakers

Nature uses as little as possible of anything.

—Johannes Kepler

POETRY

5.

A poem begins in delight and ends in wisdom.

Robert Frost

Since the dawn of time, the natural environment has inspired people to express their feelings in poetry. Poetry is also a creative outlet for expressing feelings about any aspect of the environment, including how people feel about environmental problems such as deforestation, air pollution, and population.

Poetry can also help build language skills and the ability to express feelings through writing. There are many ways to help your students appreciate poetry and write poetry. To start off, you might want to have your students write simple verse, such as Japanese haiku or cinquain. Both help capture impressions of nature and the environment using adjectives and expressive action verbs.

A HAIKU is a Japanese form of verse with three lines. The first and third lines have five syllables and the second line has seven. One idea behind haiku is that it captures the writer's first reaction to something in nature, such as a sunset, a waterfall, or a flying bird. Here's an example of a wind haiku:

Gentle, caressing
Soft breeze plays among birch leaves
Friendly wind blowing

CINQUAIN is another type of poetry that your students can try. The word comes from the French and Spanish term for five. Cinquain consists of five lines, each of which has a special purpose. Here's the basic form of cinquain:

- first line states the title in two syllables
- second line describes the title in four syllables
- third line describes action in six syllables
- fourth line expresses a feeling in eight syllables
- fifth line restates the title in two syllables.

Here's an example of cinquain poetry:

Breezes
Warm and flowing
Makes flowers and limbs sway
Always touching and surrounding
Gentle

Cyclone
Rippling, raging
Swirling funnel of death
Struggling against the violence
Terror

There are, of course, many other types of poetry, including rhyming poetry, limericks, free verse, and so on. We've included three examples of poetry about the environment. The first is rhyming verse that focuses on water pollution, the second explains what picture poetry is all about and how your students can create their own, and the third is an example of a diamante—a poem shaped like a diamond. We've also included a poetry activity that includes a reference sheet of different poetry styles.

Activities in This Section

1. **Away With Waste**, reprinted from *Ranger Rick's NatureScope: Pollution—Problems and Solutions* published by the National Wildlife Federation (1990).
2. **Picture Poetry**, reprinted from *Ranger Rick's NatureScope: Trees Are Terrific* published by the National Wildlife Federation (1985).
3. **Shades of Meaning**, adapted from *Project Learning Tree*, published by the American Forest Council and the Western Regional Environmental Education Council. Includes examples developed during an environmental education workshop held in Botswana in December 1991.
4. **Poetry Trail**, reprinted from *Focus on Forests: A Resource Manual for Intermediate and Senior Teachers on Forests and Forest Arrangement*, published by the Ministry of Natural Resources, Toronto, Ontario (1989).

AWAY WITH WASTE!

By listening to a rhyming story about water pollution in one community, your kids can discover how pollution can affect waterways. They'll also discover that the waste we wash "away" can have harmful effects later on.

Before reading the story, ask the kids to name some of the ways they use water (for drinking, bathing, brushing teeth, cleaning clothes and dishes, and so on). Then ask them what happens to the water that drains out of their washing machines and dishwashers or washes down their sinks. (Don't worry whether the kids know the answer at this point. You'll be discussing what happens to household water with them after they hear the story.) Explain that many people never think about what happens to the water they use in their households each day. They also don't think about what happens to the water that runs off their streets and yards.

Next tell the kids you're going to read them a story about a town called "Away" and about how people in the town polluted the water in a nearby bay without realizing what was happening. Tell the kids to listen carefully to the story to find out just how the water in the bay became polluted. Also tell them to listen for the word "away." Each time they hear it they should make a "hitch-hiking" motion over their shoulder with their thumb to represent something going away.

After you read the story, discuss it with the kids. Ask them if waste from Away simply disappeared. (*no*) What happened to the waste? (*it ended up in the bay*) Then go over the verses in the first half of the story to be sure the kids understood what was happening in each one. Use the information under "Where Did It Go?" on the next page to help with the discussion.

Afterward pass out crayons or markers and drawing paper and have the kids draw pictures of the story. They might draw the people in the town, the bay when it was polluted, or the bay when it was cleaned up again. If you're working with older kids, you might want to have them create their own picture books of the story. Pass out copies of page 189 and have the kids draw a picture to go along with each verse of the story. Then have them glue their pictures on sheets of construction paper, copy the words of each verse onto the pages, and staple the pages together.

OBJECTIVES:
Describe some of the ways people pollute waterways. Describe some of the effects of water pollution.

AGES:
Primary, intermediate

SUBJECTS:
Science, language arts, art

MATERIALS:
Story on the following page, drawing paper, crayons or markers, construction paper (optional), stapler (optional), glue (optional)

WHERE DID IT GO?

DOWN THE DRAIN: When most people in the U.S. rinse something down their drain, flush their toilet, or do a load of wash, the wastewater goes to sewage treatment plants to be purified. These plants remove dirt, biodegradable material such as food waste, and many other pollutants from the water before the water is dumped into waterways. But most plants can't remove all the chemical pollutants. For example, chemicals that are used in paint thinners and phosphates that are used in many detergents pass right through some sewage treatment plants.

OFF THE STREETS: Oil, dirt, litter, and anything else that's on the streets washes into storm drains. In most areas of the country, these drains empty into a series of underground pipes that eventually dump directly into waterways.

INDUSTRIAL POLLUTION: Factories that make chemicals, paper, medicines, steel, and many other products can create a lot of pollutants. At one time, industries could legally dump waste into waterways. But pollution control laws now limit the materials that industries can dump in surface water. These controls have greatly reduced water pollution. However, not all the types of industrial waste are regulated. In addition, some experts feel that some of the regulations are not strict enough to protect aquatic systems.

TRASHING THE WATER: When trash gets thrown overboard it can create an ugly mess—both in the water and on shore after it's washed up. Trash can also harm or even kill wildlife. For example, thousands of sea birds and marine mammals die each year after eating or becoming entangled in plastic debris floating in the ocean.

AWAY ON THE BAY

This is the tale of a town called **Away**—
A town that was built on the shore of a bay.
A town where the folks didn't think much about
What they dumped in their water day in and day out.

For one thing, a sink was an excellent place
To get rid of messes and not leave a trace.
Cleansers and cleaners and yesterday's lunch
Went **away** down the drain with a gurgly crunch.

At everyone's house there was laundry to do.
Day after day, how those laundry piles grew!
Load after load was washed, rinsed, and spun
And **away** went the water when each load was done.

On Main Street each day there were sidewalks to sweep.
The litter and dirt were swept into the street.
And then when it rained, everything washed **away**
Into drains in the roads that dumped into the bay.

A mill there made "stuff" for the townfolks to use,
But a pipe from the mill churned out oodles of ooze.
And the ooze, well it goozed from the pipe to the bay
Where it bubbled and glubbed as it drifted **away**.

When the weather was warm, it was always a treat
To sail on the bay and bring picnics to eat.
But when folks were finished, they'd toss all their trash
Overboard and **away** with a plop and a splash.

Then folks started seeing that things weren't quite right;
The bay had become an unbearable sight.
Beaches were covered with garbage and glop
That rolled in with the waves—and the waves didn't stop.

The fish in the bay all seemed sluggish and sick,
The algae was everywhere—slimy and thick.
The birds near **Away** were all suffering too,
'Cause the fish they were eating were covered with goo.

So a meeting was called to discuss the sick bay
And townspeople came from all parts of **Away**.
And during the meeting one person proclaimed,
"I know who's at fault: We *all* should be blamed."

"For years we've washed chemicals, dirt, and debris
Down our sinks, off our streets, and out pipes—so you see,
Although we all thought that our waste went **away**,
It all ended up going into the bay."

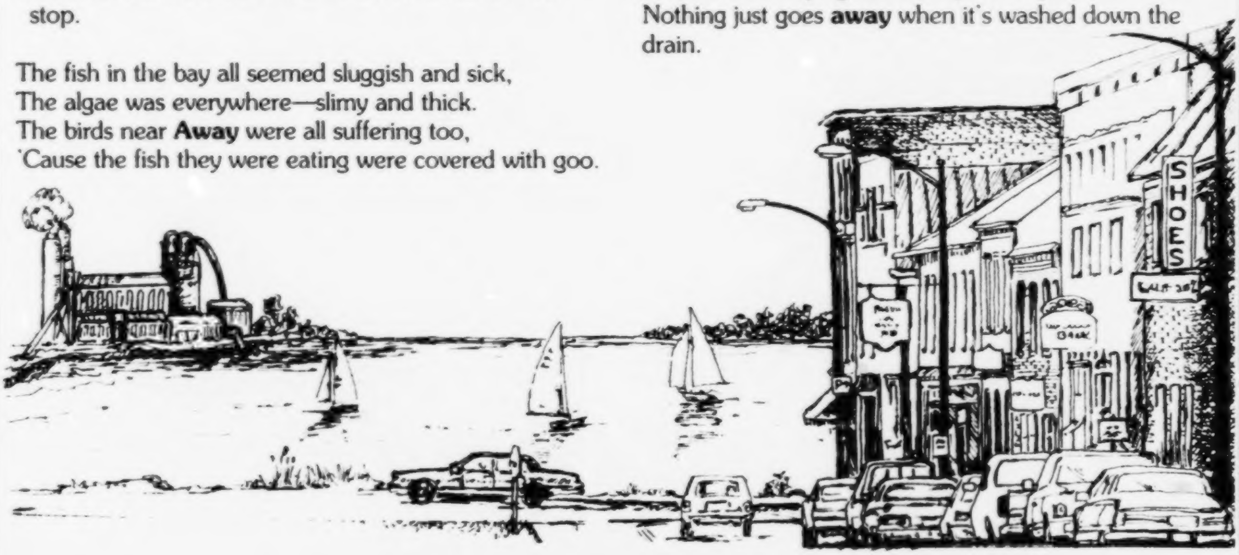
"Now the bay is a mess—full of trash, soap, and goop,
The water's turned green—like a bowl of pea soup.
And our wildlife is sick from the garbage and grime;
The bay needs our help, right now while there's time."

The folks were all silent—they knew it was true.
And they realized now what they all had to do.
It was time to get busy—the bay couldn't wait.
If they didn't act now, it might soon be too late.

So they signed an agreement that very same minute
To care for the bay and to stop putting in it
The stuff that had made the bay icky and ill,
Like soaps that pollute and the ooze from the mill.

They also agreed to stop dumping their trash
Overboard and **away** with a plop and a splash.
And all of their efforts have been a success:
Today the bay's clean and no longer a mess.

And that is the tale of the town called **Away**—
A town where the people, to this very day,
Remember a saying that's simple and plain:
Nothing just goes **away** when it's washed down the drain.



PICTURE POETRY

Objectives:
Describe what picture poetry is.
Write a picture poem about trees.

Ages:
Intermediate, advanced

Subject:
Language arts

Materials:
Chalkboard or easel paper, drawing paper, pencils, crayons or markers

Trees are terrific subjects for poems. And picture poetry is especially fun for kids because the poem's words form a picture of what the poem is about.

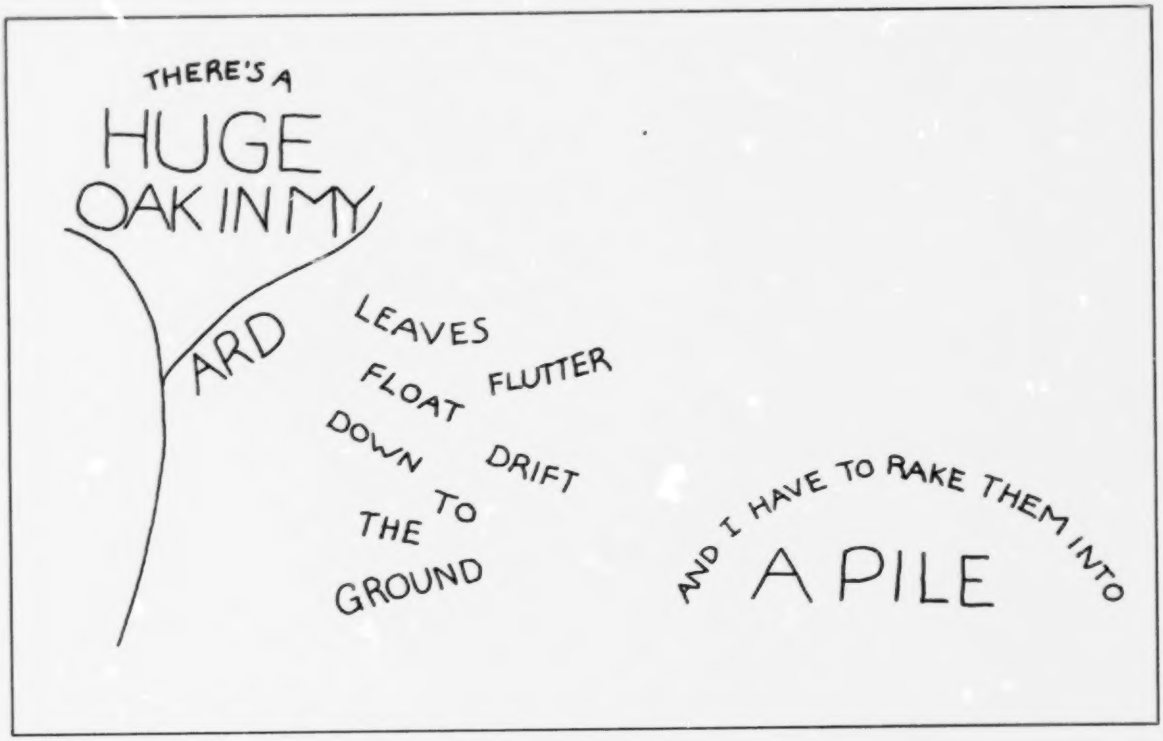
Before you get started, copy the picture poem on page 191 onto a chalkboard or large piece of easel paper. Then ask the kids if they can think of words that describe trees. (List the words they come up with in a place where everyone can see them.) The list might include the words *towering, huge, musty, mossy, slippery, gnarled, twisted, knobby, rough, bumpy, smooth, witchlike, dead, skinny,* and so on. (You might want to take the kids outside and let them look at several trees and feel their bark before you brainstorm a list of adjectives.)

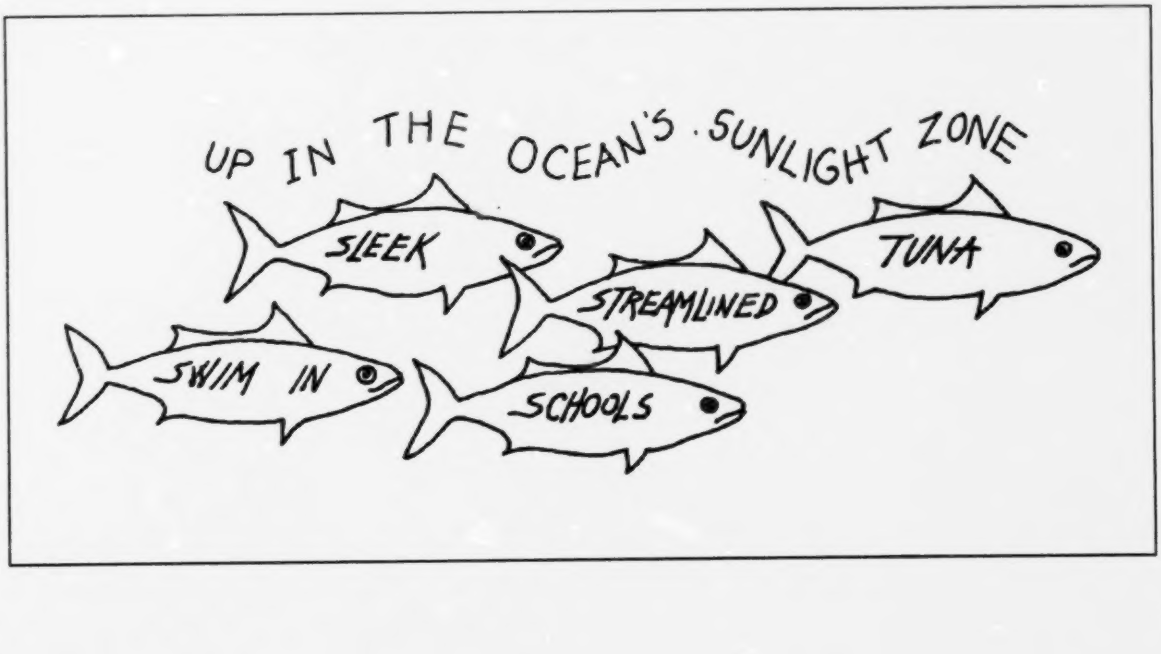
Now tell the kids that when we hear or read descriptive words that make pictures in our minds, we say that the words are a form of *imagery.* For example, have the kids imagine "an old tree by the side of a road." Ask them what they imagined. Then have the kids try to picture "a gnarled tree whose long branches bend over a road like huge arms." Ask them how the second tree they imagined was different from the first. Explain that the second sentence created a more precise image because it described the tree in more detail and used more descriptive words.

Next explain that words can also be written so that they form a picture right on the page itself. Then point to the picture poem you copied. Ask the kids if the poem would be as much fun to read if it were just written across the page instead of in the form of a picture. Talk about how some of the words (for example, *flutter, float* and *drift*) are written in a way that describes their meaning.

Now have the group make up their own tree picture poems. Be sure to explain that the words in their poems can rhyme if they want them to but that they don't have to rhyme. Also, the lines don't have to be a certain length, and punctuation isn't necessary. The kids just have to form a picture with the words that they write.

PICTURE POETRY


THERE'S A
HUGE
OAK IN MY
ARD
LEAVES
FLUTTER
FLOAT
DRIFT
DOWN
TO
THE
GROUND
AND I HAVE TO RAKE THEM INTO
A PILE


UP IN THE OCEAN'S SUNLIGHT ZONE
SLEEK
TUNA
STREAMLINED
SWIM IN
SCHOOLS

SHADES OF MEANING

OBJECTIVES
Use a poetic form to explore a spectrum of ideas related to natural resources.

AGES:
Intermediate

SUBJECTS:
Language arts, humanities

MATERIALS:
Paper, pencils

Ask the students to write a diamante (a poem shaped in the form of a diamond) having something to do with natural resources and that demonstrates that words are related through shades of meaning from one extreme to the opposite extreme. For example, "birth" and "death" are two words that can serve to represent opposites. Any words the students choose will have either literal or metaphoric meanings related to natural resources, or both.

birth
green bright
shining growing blooming
heat motion sun food
fading slowing dimming
brown old
death

The words chosen should match the following pattern of parts of speech:

noun
adjective adjective
participle participle participle
noun noun noun noun
participle participle participle
adjective adjective
noun

Suggested pairs of words with opposite meaning might include:

Exploitation — Preservation
Freedom — Regulation
Harvest — Planting
Harmony — Discord
Materialism — Asceticisim
Diversity — Uniformity
Use — Misuse

Wilderness — Megalopolis
Cost — Benefit
Fertility — Barrenness
Abundance — Scarcity
Rain — Drought
Whole — Fragment
Beginning — End

POETRY TRAIL

OBJECTIVE:
Write various types of poetry in a forest setting.

AGES:
Intermediate, advanced

SUBJECTS:
Language arts

MATERIALS:
Clipboards, pencils, activity sheets, thesaurus

Take the class outdoors. Designate four different writing stations within the area. It could be four spots within an evergreen forest, in a grassy field, under the willows, in a woodlot, or in a city park. Provide each student with a copy of the activity sheet on page 195. Divide students into four groups and send each to a different writing station.

At each location, have students use one specific sense to explore the area and develop a list of descriptive words based on that sense. For example, if they choose the sense of touch, a student may write down works like "rough," "sharp," "warm," or "cool." Then have them write one of the types of poems listed on pages 193-194 using this vocabulary. (The poetry may be directly or indirectly associated with trees and forests.) Encourage students to use a different sense and a different poetry style at each station.

At set times, rotate the groups so they have a chance to write at all the stations. Once all stations have been visited by all groups, share some of the poems as a class. Have your students pick at least five new words from a thesaurus and write a poem that summarizes the day's experiences.

OPTIONAL EXTENSION

Using slide film, take several pictures at each station. Have students prepare a forest slide show based on these pictures and their poetry.

POETRY STYLES

ACROSTIC: Verses where the first letters of each line name someone or something or convey a special message. For example:

busy
interesting
refined
dazzling
spirited
= birds

natural
always
truth
untouched
raw
everlasting
= nature

Alliteration: Verses where all the words begin with the same letter.

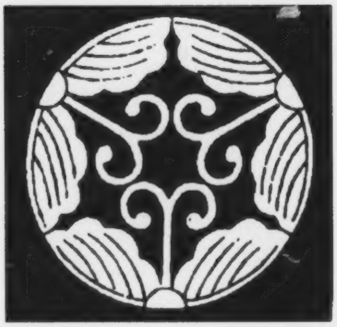
For example:

Two tall trees try to touch tenderly.
Five freaky frogs fight fearlessly.

Haiku: A form of Japanese poetry that follows a structured pattern.

For example:

Line 1: 5 syllables	Soft wings fluttering
Line 2: 7 syllables	Bright colors flying through air
Line 3: 5 syllables	Lovely butterfly



Windsparks: Verses with the following pattern:

Line 1: "I dreamed"
Line 2: "I was" someone or something
Line 3: Where
Line 4: Action
Line 5: How

For example:

I dreamed
I was poison ivy
In the woods
Providing itches and rashes
Gleefully

I dreamed
I was a leaf
Growing in the forest
Providing food for caterpillars
Unwillingly

Cinquain: Verses with the following pattern:

Line 1: One word title
Line 2: two words describing title
Line 3: three words showing action
Line 4: four words showing a feeling about the title
Line 5: one word (simile or metaphor for the title)

For example:

Water
Still, quiet
Reflects, listens, shimmers
Waiting for a splash
Silence

Trees
Monumental, majestic
Towering, soldiering, guarding
Whispering giants standing tall
Sentries

POETRY TRAIL ACTIVITY SHEET

Name ______________________________ Station No. __________

Which sense have you chosen? Check one:

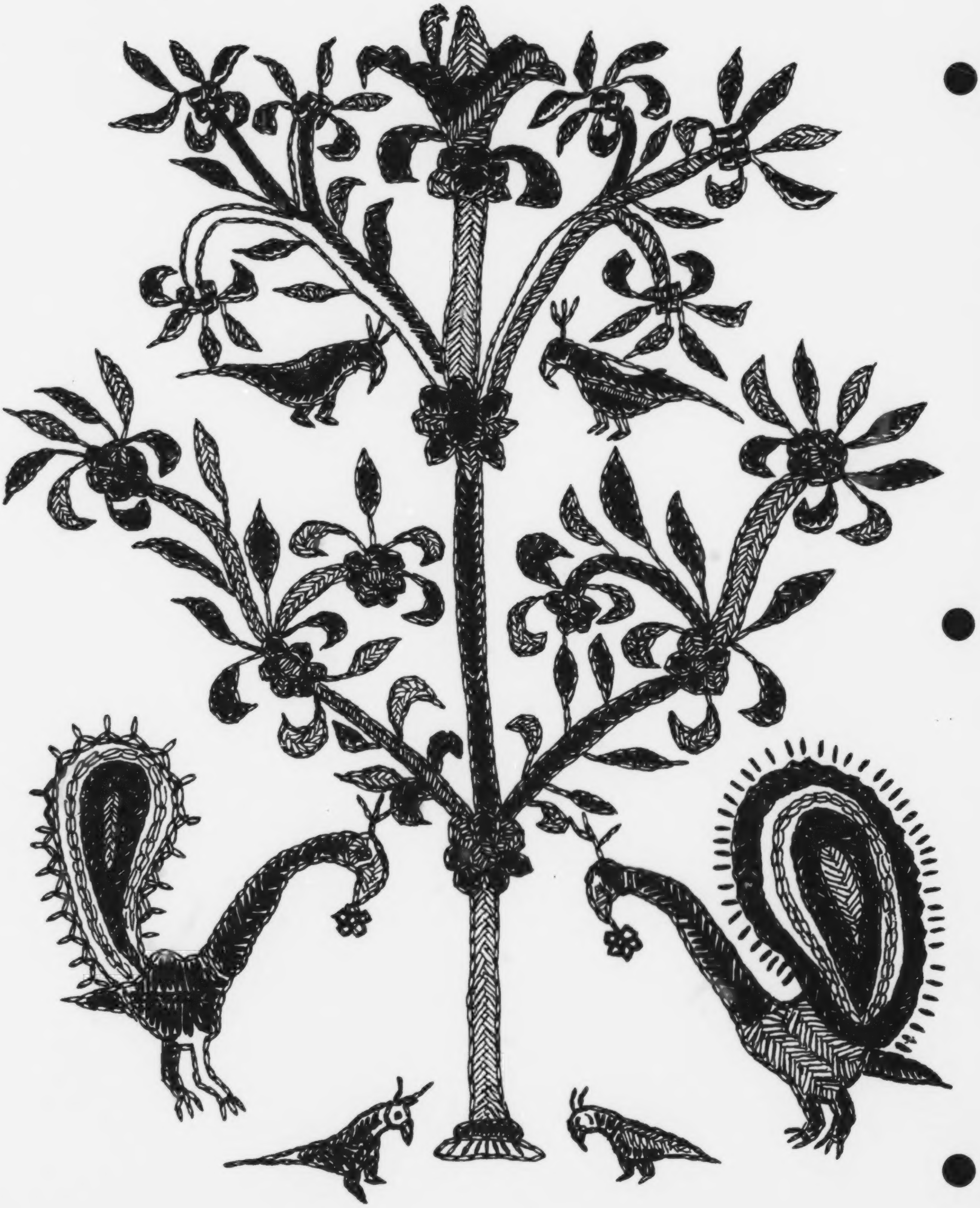
☐ Hearing
☐ Sight
☐ Touch
☐ Smell

Some common descriptive words	Synonyms from a thesaurus

POEM

Which type is it? ____________________

____
____
____
____
____
____
____
____
____
____
____
____



6.

CARTOONS, FANTASY, AND CREATVIITY

Creativity involves breaking out of established patterns in order to look at things in a different way.

—Edward de Bono

Cartoons can help liven up a lesson plan and help motivate students. They're also effective tools to help promote critical and creative thinking skills. For example, by having students analyze environmental political cartoons and comic strips focusing on culture and lifestyle, students can compare and contrast cultural attitudes, discuss differing opinions about environmental issues, and examine values and beliefs. They can also develop creative skills by developing their own cartoons and comic strips and sharing them with others.

Using fantasy in the classroom can also liven things up. For example, having students read and analyze stories about environmental conditions on a made-up planet or looking at how fantasy creatures are adapted to environmental conditions can help students apply the information they learn.

In this section, we've included activities that use cartoons and fantasy to help students investigate and understand environmental issues. In the first activity, students read descriptions of endangered fantasy animals to discover what makes an animal more prone to extinction. In the second activity, students use humor and cartoons to discuss forest-related issues. In the third example, a cartoon about ozone helps students understand why the ozone layer is thinning over many parts of the world.

ACTIVITIES IN THIS SECTION

1. **THE RARE SCARE**, reprinted with permission from *Ranger Rick's NatureScope: Endangered Species—Wild and Rare*, published by the National Wildlife Federation (1988).
2. **CARTOONS AND HEADLINES**, reprinted with permission from *Project Learning Tree*, published by the American Forest Council and the Western Regional Environmental Education Council.
3. **HOLEY OZONE,** reprinted with permission from *Ranger Rick's NatureScope: Pollution—Problems and Solutions*, published by the National Wildlife Federation (1990).

THE RARE SCARE

OBJECTIVES:
Define endangered, threatened, and extinct. Describe several characteristics that make an animal extremely susceptible to extinction.

AGES:
Intermediate

SUBJECT:
Science

MATERIALS:
Copies of page 202, index cards, markers, easel paper or chalkboard

Rhinoceroses, pandas, condors, and many other endangered species have more in common than just their endangered status. Many share characteristics that make them extremely susceptible to becoming extinct. Start off the activity by passing out a copy of page 202 to each person. Explain that each of these animals is imaginary, but each has characteristics that are similar to those of real animals living today. Have the kids read the information given for each animal, then have them decide which of the animals would be the first to become extinct as more and more people move into the area where each animal lives.

After each person has picked an animal, take a tally to see how many kids voted for each animal. Ask the kids why they picked these animals. Then explain that many animals that are threatened or endangered share one or more characteristics that make them more prone to extinction. Discuss some of these characteristics, using the information below. After the discussion, have the kids look at page 202 again to see if they agree with their original choices. Then take another tally and compare the results to those of the first one.

Explain that the crested crabbit is the animal that will probably become extinct first because it has so many of the characteristics that make an animal susceptible to extinction. For example, it has a very limited range, has a low birth rate, has a very specialized diet, migrates and nests in only one type of tree. Explain that animals that have one or more of these characteristics usually do fine until people-related problems, such as habitat loss and pollution, start to affect them.

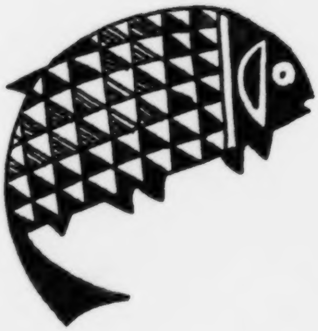
ANIMALS ARE MORE PRONE TO EXTINCTION IF THEY . . .

INTERFERE IN SOME WAY WITH PEOPLE'S ACTIVITIES: Explain that some animals may kill livestock, eat or ruin crops, or feed on animals that people also like to eat. And because they interfere with people's activities, these animals are often shot, poisoned, or harmed in some other way. Ask the kids if they can think of some examples (many predators, such as eagles, wolves, jaguars, and tigers as well as geese, ducks, and other birds that sometimes eat crops).

MIGRATE: Animals that migrate usually depend on several different habitat areas. Because of this, they can be very vulnerable to habitat destruction. For example, many songbirds that migrate to tropical forests in winter are in trouble because thousands of acres of their rain forest habitat have been developed into pastures, farms, towns, and roads.

HAVE VERY SPECIFIC FOOD OR NESTING REQUIREMENTS: Some animals are super "picky" about what they eat or where they live, or both. These specialized animals, which are often adapted to eating only one type of food or living in only one type of area, can become endangered if their food source or nesting site disappears. For example, the Delmarva fox squirrel once thrived in the open forests that grew along the Eastern Shore of Maryland, Virginia, and Delaware. As more and more of these forests disappeared, so did the squirrels. And today the Delmarva fox squirrel is listed as an endangered species.

Are Very Sensitive to Changes: Many animals have a very difficult time adapting to changes in their environment. For example, birds of prey and many other animals are very sensitive to chemical changes in their environment, such as the introduction of pesticides. Other animals have a hard time competing with introduced species that have the same nesting or food requirements. For example, bluebirds—a species native to North America—have a hard time competing for nesting sites with starlings, which were introduced from Europe in the early 1900s.



Have Small Broods and Long Gestation Periods: Ask the kids if they can think of some animals that give birth to only one or two young every year or every two or three years (elephants, bats, condors, and so on). Explain that when the populations of these animals drop, it takes much more time for their populations to recover because of the low birth rate. And the animals sometimes become extinct before they have time to make a comeback.

Animals with low birth rates have another problem, too: They don't reproduce fast enough to produce offspring that can adapt to changing conditions. Have the kids compare the reproductive capabilities of an elephant with those of a cockroach. Explain that on the average, an elephant has about three young every 10 years and that a cockroach has 80 young every half year. Copy the following figures on the board and explain that if all the animals lived and mated, here's the number of young produced in each generation. (*Note: These figures are simplified and represent approximate numbers of individuals per generation.*)

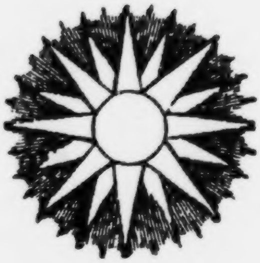
Elephant		**Cockroach**
3	1st Generation	80
6	2nd Generation	3,362
13	3rd Generation	137,842
28	4th Generation	5,651,522
61	5th Generation	231,712,403
132	6th Generation	9,500,208,482

Ask the kids to compare the number of years it takes an elephant and a cockroach to produce a 6th generation. (Since an elephant has an average of 3 young every 10 years, and a cockroach has an average of 80 young every half year, it would take elephants 60 years to produce 6 generations, and only 3 years for the cockroaches to do the same.) Emphasize that because of their high birth rate, cockroaches have more opportunities to adapt to changes in their environment.

Are naturally rare: Some animals are rare throughout their range, and others have a very limited range. In both cases, the animals are often vulnerable to habitat destruction and other people-caused problems. For example, many of the native plants and animals that live on the islands of Hawaii are naturally rare. And as more people move into the area, many of these already rare plants and animals face habitat loss, competition from introduced species, new diseases, and other problems.

BRANCHING OUT: "PICKY" EATERS

To demonstrate why specialized animals are often more susceptible to extinction, play this action game outside. Before starting, make a set of food cards by drawing the symbols and words, shown in the chart below, on index cards. For a group of 30 kids, you should make 10 fruit, 15 leaves, 15 insects, 10 small mammals and reptiles, 10 birds and eggs, and 10 snails.



Also copy the chart on a chalkboard or piece of easel paper so the kids can see which symbol stands for which food items and which foods each team eats. Before going outside, divide the group into five teams and give each team a number. Then tell them to look at the chart to see what they eat. For example, the kids in Team #1 are animals that eat fruit, leaves, insects, small mammals and reptiles, birds and eggs, and snails. And the kids in Team #2 are animals that feed on insects, small mammals and reptiles, eggs, and snails.

Now go outside and spread the food cards in a large playing area. (It's a good idea to play this game only on non-windy days.) Remind the kids what each team can eat and what each card represents. Then have the kids form a huge circle around the playing area. When you say "go," have the kids get down on their hands and knees and crawl around the playing circle to find food. (If the ground is wet or muddy, have the kids hop instead of crawl.) Tell them to collect as many food cards as they can find, but that they should collect only the type of food they can eat. For example, the kids in team #4 would be able to collect only insects, leaves, and fruit.

> *Endangered species are sensitive indicators of how we are treating the planet, and we should be listening carefully to their message.*
>
> —Donald Falk

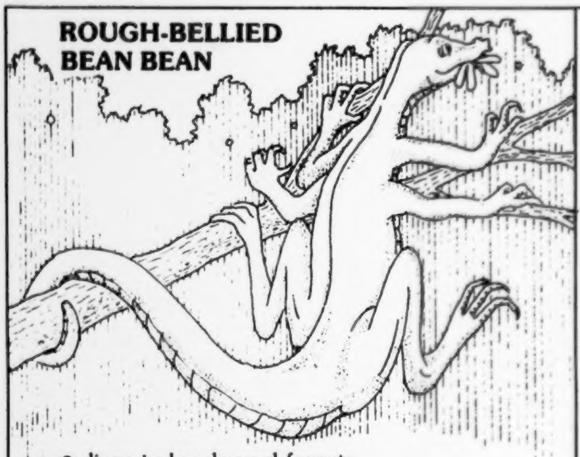
After all the cards have been collected, have the kids count how many they have. Explain that to survive, each animal needs at least two food cards. How many animals didn't find enough food?

Now play again, but explain that people have destroyed much of the habitat in the area to build an airport, shopping mall, and housing complex. Take away five of each type of food card and scatter the cards again. Which animals survived the second time? Ask the kids which animals had the hardest time surviving and why. (The animals in team #5 probably had the hardest time because they had the most specialized diet and when their food source became depleted, they would have starved. The non-specialized eaters, on the other hand, could eat another type of food when one of their food sources became depleted.) Finally, point out other examples of animals living in North America that have very specialized food or nesting requirements. (Snail kites feed on only one type of snail, Kirtland's warblers nest only in jack pines, red-cockaded woodpeckers nest only in old growth forests, black-footed ferrets feed mainly on prairie dogs, and so on.)

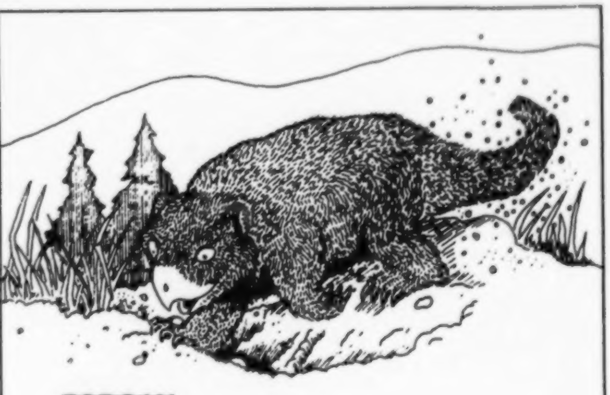
TEAM #	 **FRUIT**	 **LEAVES**	 **INSECTS**	 **SMALL MAMMALS AND REPTILES**	 **BIRDS AND EGGS**	 **SNAILS**
1	X	X	X	X	X	X
2			X	X	X	X
3	X	X				
4	X	X	X			X
5						X

THE RARE SCARE

ROUGH-BELLIED BEAN BEAN



- lives in hardwood forests
- feeds on fruit, leaves, insects, small mammals, and eggs; especially fond of flitter beetles and borga beans
- has two broods per year (average number of young per brood is four)
- lives in social groups called palpals
- some groups migrate; others stay in the same area year round

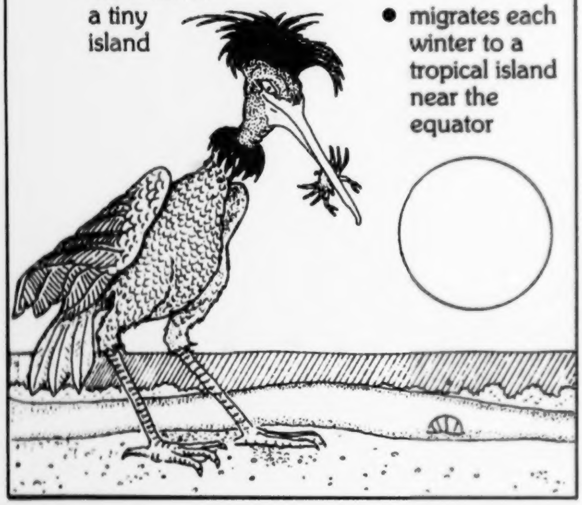


ZORGAN

- lives in burrows
- is often found in hilly and mountainous areas north of the equator
- feeds on camcams, miras, and other fruits
- mates for life
- can have two or three broods per year, but usually has one; often gives birth to twins, but one of the twins usually dies
- is noted for its beautiful blue fur

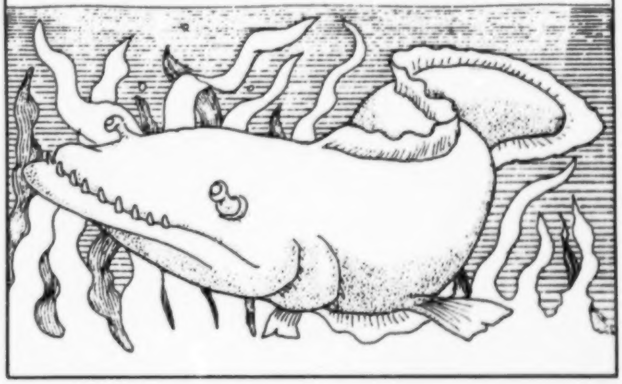
CRESTED CRABBIT

- is noted for its shiny purple crest feathers
- lays two eggs every other year
- feeds on white-backed sand crabs
- huge flocks gather during the mating season
- nests in rough-barked pine trees along the coast of a tiny island
- migrates each winter to a tropical island near the equator



GREEN GOOR

- lives in streams and marshes
- feeds on fish, eggs, tadpoles, and aquatic insects; especially fond of mosquito larvae
- hibernates in clusters in the mud during cold months
- lays an average of five eggs each year; eggs are sensitive to pesticide poisoning
- has been introduced into other areas to help control mosquitoes



CARTOONS AND HEADLINES

Ask students to write "not-likely-to-happen-headlines" with an accompanying lead paragraph relating to the origin of some forest issue or use of some forest resource. Examples are:

- Lumber Harvested in National Parks
- Wilderness Organizations Want Grand Canyon for Landfill
- Timber Interests Advocate Raising Home Interest Rates
- Decaying Organisms Unnecessary, Says Forest Ecologist

Discuss why each headline is unlikely. What conditions would have to occur before the headlines would be probable? Are any of these conditions likely to happen in the future?

VARIATION

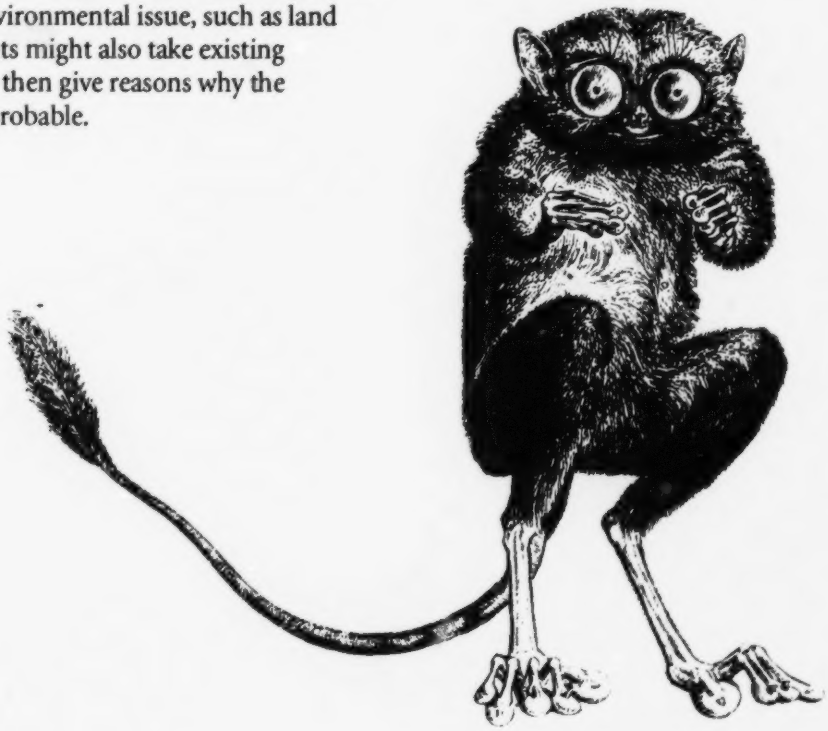
Ask students to study editorial cartoons and discuss their purpose and value as a form of communication. Then ask the students to draw humorous cartoons about a local environmental issue, such as land use, wilderness, or recycling. Students might also take existing cartoons and write new punch lines, then give reasons why the circumstance or point of view is improbable.

OBJECTIVE:
Write a humorous and unlikely headline about some phase of forest management and related issues. Give reasons why the headline is improbable.

AGES:
Intermediate, advanced

SUBJECTS:
Language arts, humanities, social studies

MATERIALS:
Pen, paper, markers and poster paper (optional)



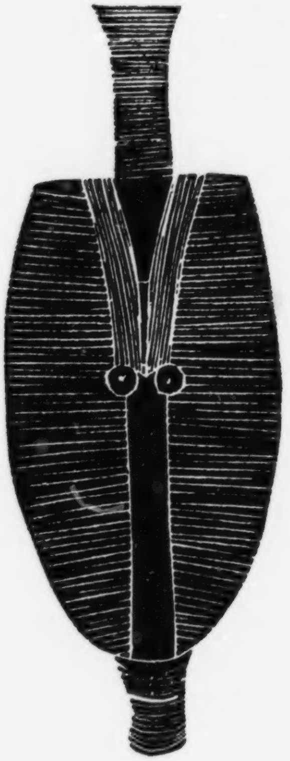
HOLEY OZONE!

OBJECTIVES:
Name several sources of CFCs. Describe how CFCs affect the ozone layer.

AGES:
Primary, intermediate

SUBJECTS:
Science, art

MATERIALS:
Copies of page 208, crayons or colored markers, drawing paper



Cartoons can make even heavy science easier to understand—and to remember. By looking at a cartoon as they listen to a story, your kids can get a better idea of how CFCs (chlorofluorocarbons) affect the ozone layer.

Start by using the background information in *NatureScope: Pollution—Problems and Solutions* to tell the kids about the ozone layer and how it absorbs harmful ultraviolet rays from the sun. Also explain that scientists have discovered that CFCs are destroying the ozone layer. Then pass out a copy of page 208 to each person and explain that the cartoon characters represent CFCs (circles) and ozone molecules (triangles). Tell the kids that you'll be reading a story that explains more about what is happening on the page. Encourage the kids to listen carefully because they'll be using the infomation later on. (In the story, we've simplified some of the information about how CFCs affect ozone. See "More About the Ozone Layer and CFCs" on page 206 for a more detailed explanation.)

After you read "The Ozone Story" (following page), answer any questions the kids may have, using the information on pages 206-207. Make sure they understand that the special conditions over Antarctica worsen the effects that CFCs have on the ozone layer in that region. You can also discuss how people can help protect the ozone layer. Then pass out drawing paper and crayons or markers, and tell the kids that they'll have a chance to create their own cartoon stories that illustrate some aspect of the CFC/ ozone problem. They can either incorporate the ozone and CFC characters from page 208 into their cartoons, or they can make up their own cartoon characters. For example, they could illustrate a CFC molecule's description of how it attacks the ozone layer.

The Ozone Story

Hi! I'm an ozone molecule. I spend my time about 15 miles above the earth, soaking up ultraviolet rays from the sun before they zap you people on earth. We ozone molecules take a lot of pride in our work. But something's been happening to us. There aren't as many ozone molecules as there used to be. And I'm here to tell you why.

You see, it all started when you people began using chemicals called CFCs. You may not realize it, but you probably use something made with CFCs just about every day. You can see some of these products, such as the plastic foam plates, scattered on the ground. CFCs are used to make the coolants that are in refrigerators and air conditioners. They're used to make computer parts. And CFCs are used to make some plastic foam cups, plates, and other containers.

But CFCs don't stay in those products forever. Look at the old cars in that junkyard—there are loads of CFCs leaking out of the old air conditioners. CFCs also leak out of plastic foam cups and plates as the foam slowly breaks apart. And see that plastic foam factory over there? Lots of CFCs leak into the air as plastic foam is being made. Once they get into the air, CFCs slowly drift higher and higher. In fact, it may take them 10 or 15 years to get way up here where I am. But the longer, the better, as far as I'm concerned. Because once CFCs get near us ozone molecules—well, that's when the trouble begins.

Before CFCs get up here to the ozone layer where we ozone molecules hang out, they're protected from the sun's powerful ultraviolet rays. That's because me and my ozone pals soak up these ultraviolet rays. But when those CFCs drift through us ozone molecules and come out above the ozone layer . . . WHAM! They get zapped by those rays! And a terrible change takes place in the CFCs. They become OZONE EATERS! You can see ultraviolet rays hitting some of the CFCs that just drifted above the ozone layer.

Once CFCs become ozone eaters, they can do a lot of damage. Why, I've heard some of those big-mouthed ozone eaters brag that they've destroyed 100,000 ozone molecules! And as more of us ozone molecules are destroyed, the ozone layer is becoming thinner, and more harmful ultraviolet rays are reaching the earth.

The ozone molecules over Antarctica have really big problems. Down there, the super-cold temperatures make lots of ozone eaters form. I've heard that during some parts of the year, almost half of the Antarctic ozone molecules get eaten. I'm glad I don't live there.

Well, that's the end of my story. Now that you know what's happening up here, I sure hope you'll do something to help us ozone molecules. After all, we've been saving your skin for years!

Action Tip!
CFC Control

- *Avoid using and buying products that might be made with CFCs. For example, use a reusable cup instead of a plastic foam one. If you're not sure if CFCs are in a product, ask the retailer. Even if they don't know, you'll be informing them that consumers are concerned about CFCs.*
- *When servicing your car, take it to a station that can recycle the air conditioning coolant and keep CFCs from being released into the atmosphere.*
- *Have home and car air conditioners checked for leaks.*
- *Use air conditioners only if needed for health or safety reasons.*

MORE ABOUT THE OZONE LAYER AND CFCS

OZONE DYNAMICS: Ozone is a form of oxygen. Ozone molecules can be found from 15 to 20 miles above the earth, with the peak concentration (the ozone layer) occurring at about 15 miles. Although ozone absorbs most of the ultraviolet (UV) rays from the sun, it makes up only a very small fraction of the atmosphere.

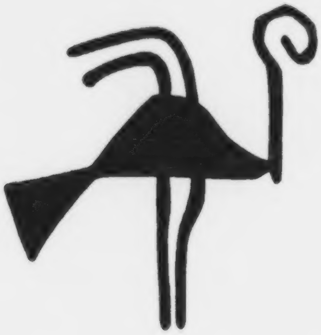
The ozone supply is constantly being recycled. When an ozone molecule absorbs UV light, the molecule splits apart. A new ozone molecule soon forms from the "old parts." If left undisturbed, this cycle maintains a balance of ozone in the atmosphere.

CFCS ENTER THE PICTURE: Chlorofluorocarbons, or CFCs, were invented in 1930. Many different kinds of CFCs have been developed since then. Because they are so stable (that is, they won't easily react with other chemicals) and nontoxic, CFC have been used to make a variety of products, such as aerosol propellants, coolants, and plastic foam. (Some plastic foam products are now being made with CFC-substitutes, but there's no way to distinguish these products from those made with CFC-containing foam. And many CFC substitutes, such as HCFCs, also harm the ozone layer.)

OZONE WRECKERS: As a CFC molecule drifts above the ozone layer, it's bombarded by the UV rays of the sun. This splits apart the CFC molecules, releasing an atom of chlorine, which in turn "attacks" an ozone molecule. The chlorine atom breaks apart the ozone molecule in such a way that it can't recombine to form a new ozone molecule. This disrupts the ozone cycle, resulting in a net loss of ozone.

Scientists have found that a single chlorine atom can destroy up to 100,000 ozone molecules before it becomes inactive or drifts down into the lower atmosphere. This means that introducing just a small quantity of CFCs into the atmosphere can have a big effect on the ozone layer. Scientists have also found that some types of CFCs are more harmful than others, because they last longer in the atmosphere (about 100 years) and release more chlorine molecules.

POLAR PERILS: From June to August, the extremely cold winter temperatures over Antarctica help to foster the formation of chlorine molecules, and create a temporary but extreme thinning of the ozone layer. By September, a "hole" the size of the U.S. may form. Ozone levels may drop by as much as 50 percent in the annual Antarctic ozone hole. This hole disappears when temperatures warm up around late November.



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Ozone Around the World: In contrast to the severe ozone depletion over Antarctica, scientists have found that Arctic ozone levels drop by only 5 to 10 percent during the winter. This less drastic depletion is related to the shorter, warmer Arctic winters. Scientists have also detected a 2 to 3 percent drop in average worldwide ozone levels. Some scientists believe that because of this ozone depletion, more of the sun's harmful UV rays are reaching the earth. Many scientists feel this is responsible for a rise in the number of cases of skin cancer.

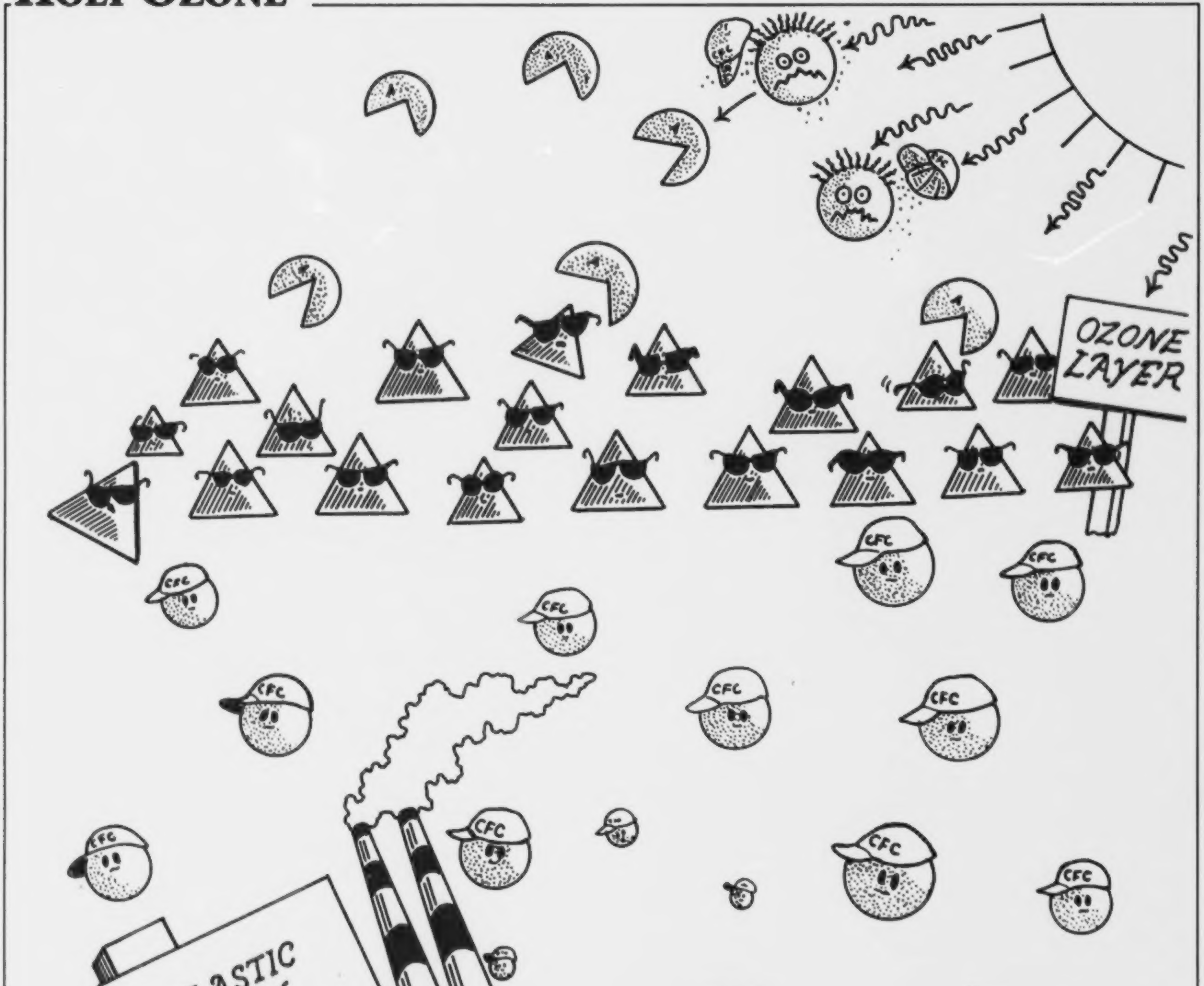
Saving the Ozone: Alarmed by warnings from scientists, the U.S. and a few other nations banned the use of CFCs in most aerosols in 1978. Then, in 1985, the announcement of the Antarctic ozone "hole" spurred governments to work together to cut worldwide use of CFCs. Countries eventually agreed to phase out CFCs altogether by the year 2000 and to help less developed countries find alternatives to CFCs.

Until CFCs are phased out, consumers should be particularly careful to avoid products made with the following types of CFCs. Although all CFCs can damage the ozone layer to some extent, these CFCs are particularly harmful:

- trichlorofluoromethane (CFC-11)
- dichlorodifluoromethane (CFC-12)
- trichlorotrifluoroethane (CFC-113)
- dichlorotetrafluoroethane (CFC-114)

Consumers should also be on the lookout for products containing HCFCs.

HOLY OZONE


CFC
OZONE LAYER
PLASTIC FOAM FACTORY
Junk Yard

7.

GUIDED IMAGERY

It may be those who do most, dream most.

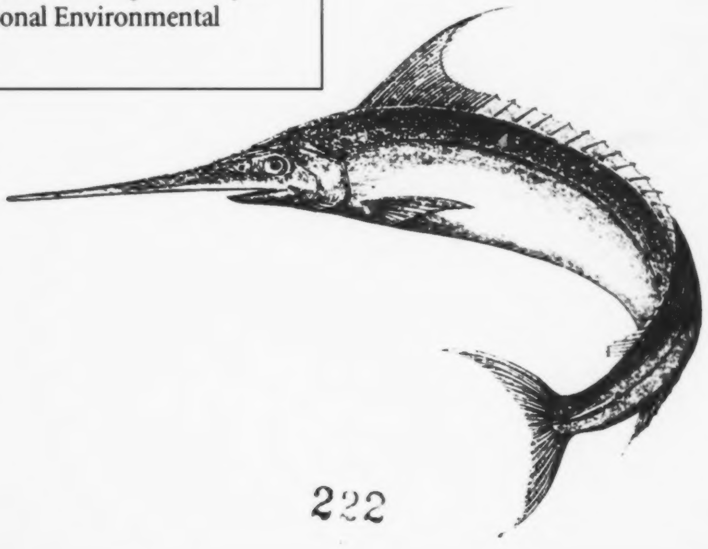
—Stephen Leacock

"Close your eyes and relax. We're about to take a trip into outer space." So begins a guided imagery that takes students into deep, dark space—where they visualize what occurs during the life and death of a star. Guided imagery is a way to let your students create visual images in their minds and think about things in ways they might not be used to.

You can create guided imageries to help students focus on their feelings, understand a concept, or review something they previously learned. The environment offers unlimited potential for creating guided imageries—from understanding biological processes and environmental problems to social interactions and political processes. For example, you could develop a guided imagery to help students understand what happens to garbage that ends up in the trash or in a body of water. Or you could describe the migration of wildebeest or monarch butterflies. We've included three examples of guided imageries: the first deals with how birds and humans differ, the second focuses on what a riparian zone is all about, and the third looks at the water cycle. (The guided imagery on the life and death of a star mentioned above can be found in *Ranger Rick's NatureScope: Astronomy Adventures,* "Birth and Death of a Star" on page 7.)

ACTIVITIES IN THIS SECTION

1. **FLIGHT OF FANTASY,** reprinted with permission from *Ranger Rick's NatureScope: Birds, Birds, Birds!* published by the National Wildlife Federation, 1989.
2. **RIPARIAN RETREAT**, reprinted with permission from *Aquatic Project WILD,* published by the Western Regional Environmental Education Council, 1987.
3. **WATER WINGS,** reprinted with permission from *Aquatic Project WILD,* published by the Western Regional Environmental Education Council, 1987.



FLIGHT OF FANTASY

OBJECTIVES:
Describe the special characteristics that help a bird fly. Compare birds to people.

AGES:
Primary

SUBJECTS:
Science, creative writing, art

MATERIALS:
Crayons, pencils, paper, yardsticks, tape

What would it be like to soar among the clouds or ride high on a thermal? In this activity your group will get a chance to imagine what it feels like to fly by listening to a very special story. Have the kids close their eyes and take a few deep breaths. Tell them to relax their bodies and to let their imaginations soar as you read the following story out loud:

FLIGHT OF FANTASY

You are going to travel to places you've never been before, moving high above the earth. But first your body must change, for it is now too heavy and would never get off the ground.

Think of your feet and notice how they feel. Wiggle your toes and bend your ankles. Your feet begin to feel warm. Each ankle is getting squeezed and keeps growing until it is very skinny and long. One of your toes disappears and you now have only four. But not all face in the same direction. Three are held in front and one sticks out of the back of your foot. The end of each toe has a very sharp, curved toenail. You feel the outside of your feet and ankles slowly change from smooth skin to rough, bumpy scales. There is a perch in front of you and you hop over to it and feel your toes close around it. You are now perching.

Each leg becomes short and your knees pull up close to your body. You feel your body tip forward and become much shorter. And your insides shrink as your body becomes very slim and compact.

Suddenly heat fills your hands and arms. Your fingers almost dissolve and your hands grow very long and flat and wide. Now you have wings. Flap them a few times and feel how they move.

In a flash, your whole head feels warm and everything begins to change. Your teeth disappear and your nose and mouth grow together, getting very long and hard. Finally they form a sharp, curved beak—hooked and strong.

Your chin is gone now too, and each outer ear falls off. Your eyes slide to the side of your head and they can no longer turn as easily in their sockets. You have to turn your whole head to look around. The ear holes move close to your eyes, beneath and behind them.

You're changing very quickly now! Each lung changes and air sacs appear in many places in your body. They are like thin balloons connected to your lungs. Air spaces invade your dense bones and make them much, much lighter than they were. Hairs begin to grow all over your body. But wait, they're not hairs! They're feathers—covering you all over except for your beak and feet. Soft down feathers grow close to your body and longer, wider feathers cover your body, shape your wings, and form a broad tail. When you try to speak, only a loud, hoarse call comes out.

A great urge to go outside comes over you, and you hop down off your perch and hop quickly to the nearest door. As you face outside, the wind calls to you and you jump, flapping your wings quickly and with great force. Up you go—over the trees and buildings and toward the sky. A great, warm gust of wind pushes up under your wings and lifts you higher and higher until the trees look the size of buttons.

A mouse runs across a field far below you, and you can see its shape very clearly, even though you are up so high. All of the colors of the earth look beautiful down below—green leaves, brown earth, and blue water. Buildings and cars of all colors are connected with roads that look like thin lines.

As you circle on the rising winds the breeze rushes around your body. You see a puffy, white cloud ahead, and with a few flaps of your wings and a tilt of your tail you glide into the whiteness. It is cool and damp and you feel lost for a moment. Then you come out on the other side and see a great range of mountains on the horizon.

The mountains and the sky are your new home. As you fly high above the earth, you let out a long, loud cry. You are now called Eagle.

Have the children imagine that they are now back in their seats where they began their journey. Tell them to open their eyes slowly. Then have everyone stand up and stretch.

Ask them what their favorite part of the journey was. Discuss some of the changes that happened. Then have the children draw a picture of what they think the eagle might see as it looks down. How would trees look from above? Buildings? Water? Fields? You can also have them write a story that continues where the "Flight of Fantasy" left off.

BRANCHING OUT

Have the kids compare their "armspans" to the wingspan of an eagle. Divide the group into teams and give each team some masking tape and a yardstick. Have each team go to a different wall and measure out seven feet (2.1 m), the eagle's wingspan, marking the distance with two small pieces of tape. Then have each person go up to a wall and hold his or her arms out. How does each person's armspan compare to an eagle's wingspan?

RIPARIAN RETREAT

OBJECTIVES:
Describe habitat characteristics of riparian areas. Identify animals that inhabit them. State the importance of riparian areas to wildlife and humans.

AGES:
Intermediate, advanced

SUBJECTS:
Science

MATERIALS:
Water colors, acrylics, poster paints, crayons, and other art materials

Riparian areas are important and valuable in many ways. They are the green ribbons of life found on the edges of water courses (streams, lakes, ponds, etc.). Conditions there support plant communities that grow best when their root systems are near the level of high ground water. These zones range in width from narrow ribbons in desert and mountain settings to wide bands on the plains and lowlands.

Riparian areas provide space, shelter, and food for the plant and animal communities with which they are associated. For example, leaf litter and terrestrial insects falling from vegetation into a stream are a source of detritus, providing nourishment for some aquatic life. Vegetation may also provide shade from the sun for aquatic plants and animals and land-dwelling creatures at the water's edge. Riparian areas are also transportation corridors or highways for animals that depend on water bodies for food and shelter. The riparian plant community, especially shrubs and trees provides shelter and food for animals as large as deer. Trees and marshy areas provide shelter for nesting birds and the banks provide homes for burrowing animals.

The riparian zone may serve as a buffer between the uplands and the water. For example, rainfall dropping on uplands and flowing downhill can be cleansed as it flows through a riparian zone. The banks of riparian areas store water during periods of high flow such as rainstorms or snow melt and release this water to the stream during low flow times. Riparian vegetation strengthens the stream banks. This tends to prevent erosion and maintains the stream channel, keeping the water clear.

Among the many values of riparian areas, they have aesthetic and recreational values for humans. They are used for fishing, hiking, camping, picnicking, and resting. The major purpose of this activity is for students to increase their appreciation of the importance of riparian areas.

PROCEDURE

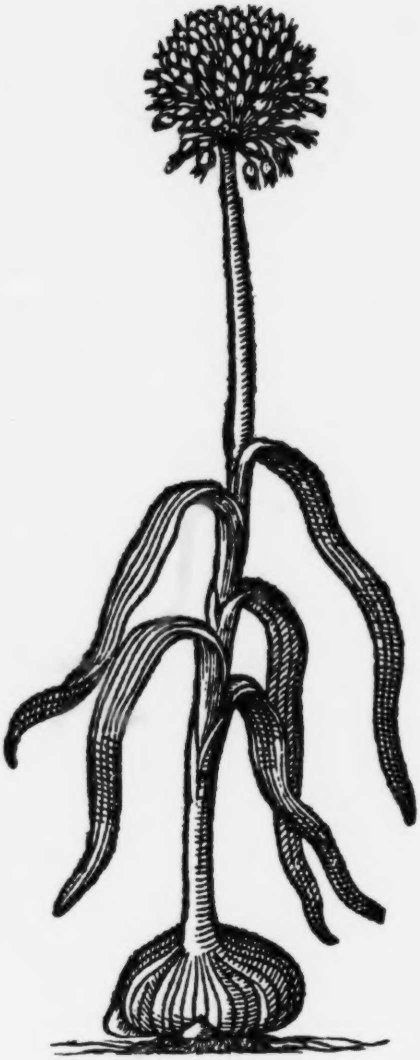
1. Find out if anyone has ever been to a stream or river bank. What was it like? Were there plants growing there? What did the area look like? Was it hot or cool? Simply encourage the students to talk and share descriptions of any area by a stream or riverbank they may have been to—or at least have seen pictures of.
2. Next tell the students that the kind of area they have been describing has a special name. In some parts of the country, it is called a riparian area. Riparian areas are important natural areas for people and wildlife. In order to learn more about these kinds of areas, the students will need to close their eyes and imagine the

things you will be describing. They will be imagining these things from their own point of view, as themselves, in the setting and circumstances you will describe. Invite the students to get in a comfortable position, close their eyes, and do their best to imagine what they hear.

Riparian Retreat

It is a hot summer day. You are walking in a meadow filled with knee-high grasses. Here and there are masses of tiny blue wildflowers. The ground beneath your feet is uneven, but you are in no hurry as you walk slowly toward a grove of trees. As you near the trees, you notice the changing colors of green. A breeze whispers through, showing first a shiny green, then a dull green underside of the leaves As you step into the grove of trees, you are surrounded with a welcome coolness. You immediately feel the protection of the canopy of green above your head. A tap-tap-tapping sound breaks into your thoughts. Searching about among the rough-barked trunks, your eyes finally spot a bird, black and white with a touch of red on its head, clinging to a vertical tree trunk and bobbing its head in time to the rhythmic tapping. Your eyes fill with the beauty of the setting. Your skin welcomes the cool. As you breathe deeply, the very scent of 'green' comes to you. The aroma of earth and growing things is strong and you detect here and there almost a memory of the sweet perfume of the flowers. Once in a while the pungent, but not unpleasant, odor of wet soil and last season's decaying leaves and grasses catches your attention.

As you explore further, you notice that the tree trunks are not as crowded and close as before. Grass, which earlier reached to your knees, is being overshadowed by chest-high bushes. Although these bushes have no thorns, they nevertheless snag your clothing. Your arms are lightly scratched by the twig ends. Several of the bushes are covered with small berries, pink and pale green, ripening into red in the warm sun.



The bushes become taller. You find yourself pulling aside thick, tangled willows taller than your head. You carefully choose a safe path along the precarious trail beneath your feet. Suddenly your left foot drops six inches and, looking down to examine the terrain more closely, you notice that where you stepped, the tunnel of a burrowing animal collapsed from your weight. Moving on again you feel the whisper of an abandoned spider web touch the side of your face. Brushing it aside, you notice the slope of the land is steeper. You pause, listening. . . listening.

You can hear the high drone of insects . . . It has come upon you so gradually, you are surprised that you didn't hear it before. . . Now it seems almost frighteningly loud. And beneath the buzzing drone, and lower in pitch and volume, is the sound of water gently spilling over rocks. Above the place where the water must be, you see thousands of tiny spots milling before your eyes, the creators of that high buzzing sound. The spots are hundreds of swarming insects in a cloud too thick to imagine. A dragonfly flashes by with its iridescent pinks and greens, darting here, pausing, *darting there, pausing, snatching dozens of the dots, relishing a meal in an unending insect buffet.*

You step aside, ducking beneath the swarming insects. You smile as your eyes come to rest on the splashing waters of the stream a few feet below. As you proceed, you use your arms to open a space to walk between the graceful green willows that bounce back undisturbed in your wake.

As your eyes comb the scene for a place to rest, you notice a hip-high rock ahead of you—gray, warm, and not yet water-smoothed. You pause before reaching the rock and bend toward the water, gathering a handful of pebbles from the stream bed. One leg anchors itself on the ground between two willows while the other reaches over to the water. With the pebbles in your hand, you swing up onto the dry perch of the rock. You settle down and look at the still wet pebbles . . . gray, pink, tan, and cool in your warm hand. After you examine them carefully, you toss the stones one at a time into the stream, listening to the pleasing plop of stone on water.

Then your eyes drift downward to the waters of the stream near the base of your rock. In an eddy you see a fish, hidden like an illusion in the stone and silt, waiting, waiting, unblinking and still only the faint wave of a gill, a tail fin, showing any evidence of life at all.

As you continue to look downstream you notice all kinds of small insects are now dancing across and above the water. A small ripple occurs in the water, then another and another. You realize that fish are rising up from below and feeding on the surface insects. Birds dart in and out of the tangle of vegetation. Some fly through.

Downstream a frog begins to croak. Much nearer, another frog offers a reply. You look around quickly to see if you can find the nearer frog. For a moment you think you spot it, but then realize that unless it sings again, you may never find it. Your eyes search for a moment as more frogs telegraph their messages back and forth. But then it seems time to leave. You take one last sweeping look all around this beautiful setting. You slowly get up from your rock along the streamside and head back home.

3. Ask the students to continue to sit quietly with their eyes closed and review the whole experience. Ask them to pay particular attention to their favorite images. Tell them they are going to be asked to describe this setting as they saw it. Invite them to open their eyes.
4. Ask them to describe their favorite images. Once each student has done this, invite all of the students to select art materials. Each should draw or paint his or her favorite images on the paper provided. Once they are finished, have the students tape up their art work on a display area.
5. Ask the students to identify some of the characteristics of riparian areas. What kinds of plants did they see? What kinds of animals? Was the environment near the water different than it was farther away from the water? If yes, what were some of the similarities and

some of the differences? Ask the students to list, describe, and discuss some of the many reasons that riparian areas are important and have value—intrinsic value as well as value to wildlife and humans.

EXTENSIONS

1. Visit a riparian habitat. Look for things that you encountered in your imagery. List things that were not in your imagery.
2. Generate a list of things that could be done to make it possible for people to visit a riparian area without damaging or destroying it.
3. Put your descriptions in writing—if you have not already! Combine words and visual images to convey some of the diversity in riparian areas.
4. Is a different word used in your region to describe these kinds of areas? If not riparian areas, what are they called?

EVALUATION

- What is a riparian area?
- Name four animals that you would expect to find in a riparian area.
- Why are riparian areas important to wildlife?
- Why are riparian areas important to humans?
- Why are riparian areas intrinsically valuable?
- Describe your position on a plan to develop a riparian habitat for recreational use by hikers, birdwatchers, and other low impact users. A parking area, restrooms, walkways, garbage removal, and other needs must be considered.

WATER WINGS

OBJECTIVES:
Illustrate the water cycle. Describe the interrelatedness of the world's waters. State the importance of water to plants and animals.

AGES:
Primary, intermediate

SUBJECTS:
Language arts, science

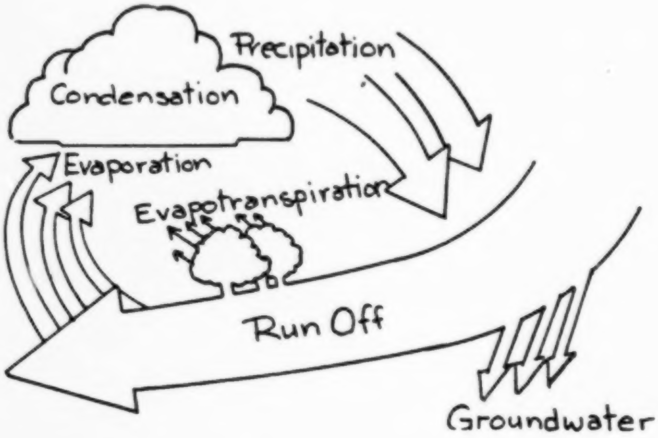
MATERIALS:
Tape recorded music, water sounds, or ecosystem recordings of an aquatic habitat, art materials (water-based paints such as acrylics, water color, or poster paints; brushes, paper, containers for water), writing materials

There is, in a sense, one body of water on planet earth. Its rivers reach in sinuous paths out from the hearts of every continent. All water, everywhere, is somehow connected. Everyone can rather easily see and sometimes physically touch this universal body of water in some form—perhaps by turning on a water faucet or by looking at clouds moving high in the sky. Lakes, ponds, and inland seas are webbed together by waters flowing across the surface of the land or in the seeping flow of groundwater. Through evaporation, condensation, and precipitation, the atmosphere transports water from place to place.

Plants also are an active part of the water cycle in many ways—including by transpiration. Transpiration is a process whereby plants evaporate moisture through the surfaces of their leaves. People seldom think of the waters of the world as being connected into one body. Maps emphasize the continents and political boundaries on land. Geographers have named dozens of seas that in reality cannot be delineated from each other—similar to the way that territorial boundaries on land tend to be more political than geographical.

Human beings are linked to the planet's watery world. Our bodies are approximately 75% water. Each molecule within us has been part of the oceanic realm in times past. Molecules of our bodies' water may have flowed in streams, lofted in air, or been locked in glacial ice. Other animals and plants are also tied to the planet's waters—directly and indirectly. Living things are partly made of water: all life depends upon water in some way.

The continuous dynamic of the movement of water is called the water cycle. The concept of the water cycle is a way to view the moving connectedness of water in its many forms. Here is one illustration of the concept of the water cycle:



The major purpose of this activity is for students to increase their understanding of the unified nature of all the earth's waters.

PROCEDURE

1. If at all possible, the students should visit a real stream, pond, lake, river, or beach. Try to choose one where human-made sounds are at a minimum. If possible and not dangerous, allow the students to touch the water during the part of this activity where they are being led through a guided imagery. Consider the possibility of taking battery-operated tape recorders on the field trip to tape some of the natural sounds the students experience for later playing once the students are back in the classroom. (*optional*)
2. If the field trip is not possible, then try to use a tape player with recordings of natural ecosystems; the sounds of oceans, rivers, streams, swamps, or brooks are often available on tape from bookstores, music stores, and shops that specialize in nature. Classical music can be substituted. "La Mer," "The Pines," and "Fountains of Rome" are examples. Any of a number of selections of "new age" music are also excellent. You can also make your own tape recordings. (*optional*)
3. Ask the students to sit or rest quietly in comfortable positions. Begin the guided imagery. If available, invite the students to relax and listen carefully to the water and/or musical sounds. These sounds are simply background for the ideas you are going to ask them to visualize in their minds. (*optional*)

Note: Please modify the water images in the text of this guided imagery as needed to adapt to your location.

You are to try to imagine the things you will hear me describing. Sit comfortably and close your eyes. . . . Relax, and do your best to imagine what I am describing. . . . You are sitting on the edge of a stream (lake, ocean, etc). . . . Your bare feet are swinging in clean, clear water. . . . The water feels good, but it is cool. . . . You feel a current washing over your feet, pulling at them. . . . Think about the water flowing past your feet until it reaches a larger stream. . . . The water connects you with the larger stream. . . . Feel its more powerful flow. . . . See the green ribbon of trees and plant life on the banks. . . . The larger stream carries the water past flat farmlands, cities, factories, and forests until it eventually reaches the sea . . . . Through your feet and the continuous currents of water you can imagine that you feel the sea. . . . Now stretch your mind and realize that you interconnect with all the world's oceans. . . . You are now touching one single body of water that stretches all around the world . . . . Your own body contains water that is part of this system. . . . Your touch laps against the shores of the Pacific Ocean, it flows under the Golden Gate Bridge in San Francisco Bay, it leaps and plunges around oil drilling platforms in the North Atlantic. . . . It pours from the sky as a storm rages dark and gray. . . . It drenches an Alaskan native who shivers on the Arctic shores before her parka begins to warm her. . . . It glistens on the back of a Greek boy

who tugs fiercely on fishing nets in the warm Mediterranean Sea. . . . Water connects your feet with every stream flowing into the oceans around the world. . . . You can reach up the rivers to the hearts of continents. . . . You can feel the tremor of the hippopotamus that just dove into an African river. . . . You can feel an alligator silently sliding toward a heron in the Florida Everglades. . . . You can feel beavers busily building a dam on a stream in Europe. . . . You can see water, thousands of tons of it, in great drifting fleets of heavy white cloud. . . . Your reach embraces all the whales, all the porpoises, all the sharks. . . . You are connected with the mythic creatures, living only in the minds of people in the past— mermaids, citizens of Atlantis, and the mythic monsters that swim in Loch Ness. . . . Your feet feel the flow of the current of the miles-wide Amazon River in South America, the ancient Nile River pushing north through Africa, the Colorado River thundering with a boatful of river rafters through the Grand Canyon. . . . Your watery embrace wraps all around the Earth. . . . And, of course, the water flowing over your feet connects you with everyone else who is now sitting, with feet dangling in a stream, wondering where the water goes. . . It is time to come back. . . . Bring the limits of your senses back from the world's rivers and oceans . . . back to the surfaces of your feet . . . back to where you are. . . . When you feel ready, you may open your eyes."

4. Once the imagery is complete, ask the students to open their eyes. Tell them that they each had their own private journey even though they all heard the same words. Tell them that in a moment you will ask them to close their eyes again to find one place on the journey through the world's waters that was their favorite—and you will ask them to try to remember what that image was like.
5. Ask them to relax again and have them try to re-create the picture in their minds. Tell them to look at the detail, the color, the plants and animals, and to try to capture it all in one scene. Have them pay particular attention to the role of water in the lives of people, plants, and wildlife.
6. When you feel they have had enough time, ask them to open their eyes. Provide the art materials and ask them to each get paint sets and paper and to quietly paint the image of their favorite place. You may provide an opportunity at this time for some or all of the students to talk briefly about their favorite places. (*optional*)

Note: If you choose the field trip instead of the classroom option, try to take water-based paints to the field so the actual water of the site can be used to paint the images. If you remain in the classroom, you might mention how some of the waters of their journey will now be used to help them paint their image.

7. Once the images are complete, ask the students to write various short forms of poetry that express some of their feelings about water and its importance.

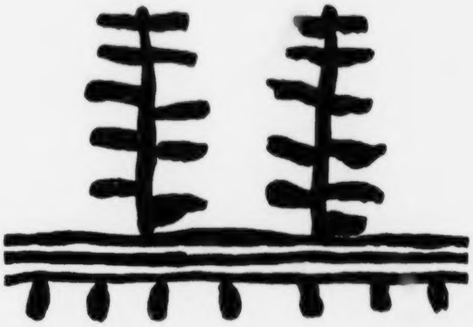
8. Display the images and poetry in a circle around a world map. With yarn, connect the images that the students painted of their favorite places to the sites where they appear on the map. (*optional*)
9. Discuss the "one body of water" metaphor. Emphasize the concept that all the waters of the world are interrelated and connected. Help the students see that the air is part of that connection, too. It is the air that carries the waters back to the rivers from the sea. Point out that watersheds are the places where the air rains its water back down on the earth's surface and it accumulates. Talk about the importance of water to people, plants, and animals.
10. End the activity with a description of the water cycle. Ask the students to describe how their favorite place, which they illustrated in their painting, is a part of the water cycle. You might want to point out that the water they used in their paintings has evaporated from the pictures and is back in the water cycle again!

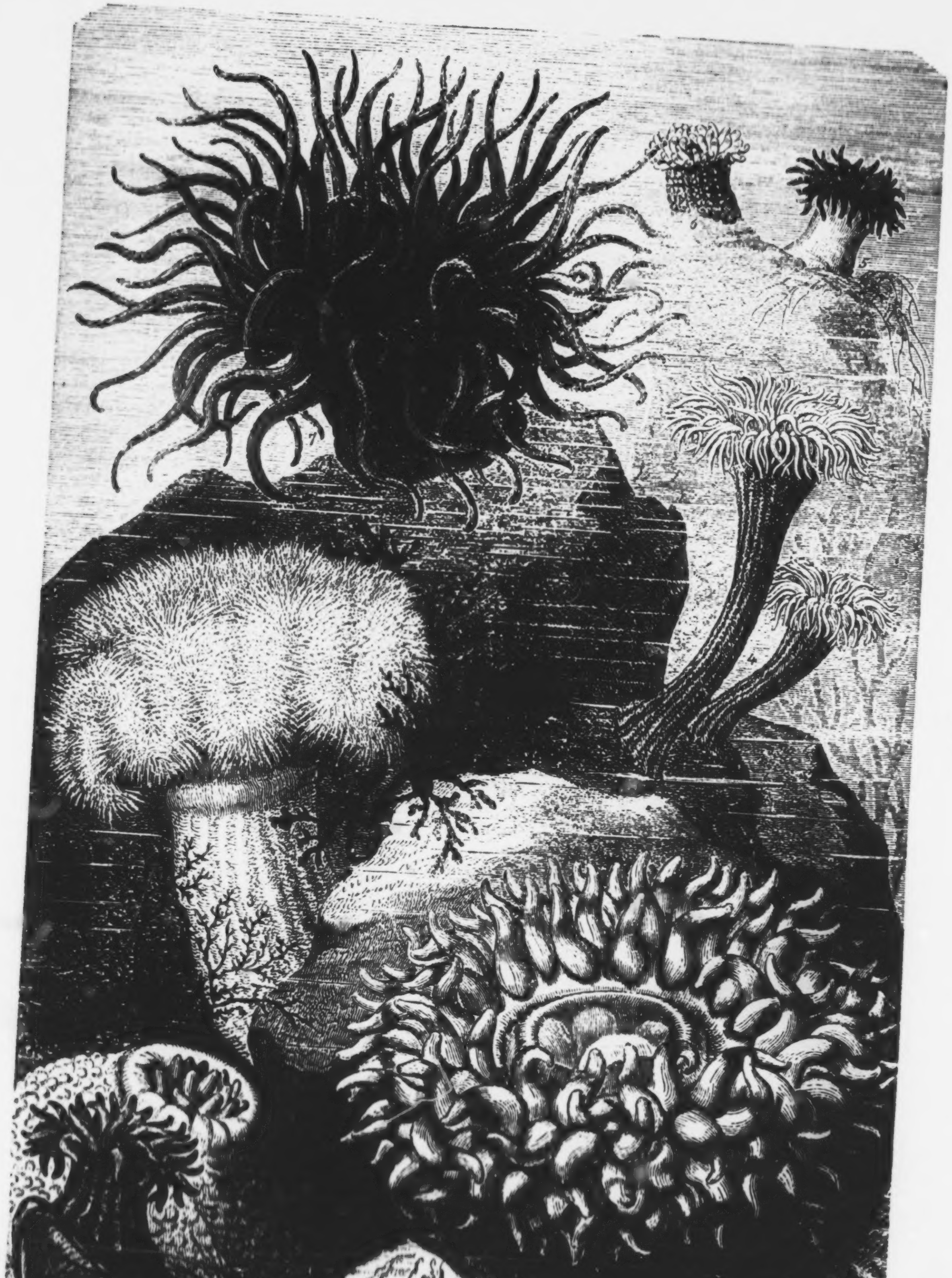
EXTENSIONS

1. Find out the annual rainfall and climate in the area you chose to paint.
2. Write a statement or poem about planetary pollution or water and attach it to the art. Write a second statement or poem about what can be done to keep the earth's waters healthy and free of pollution.
3. Trace the migratory path of a salmon, tuna, or whale and describe the qualities of the different water environments that the animal experiences.
4. Choose a freshwater body of water near you and trace its path to the sea.

EVALUATION

- Describe the water cycle. Illustrate your description.
- Describe how all of the earth's water is connected and interrelated.
- List at least ten ways that you use water every day.
- List as many examples as you can of why water is important to plants and animals.

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DEMONSTRATIONS

8.

Demonstrations can help your students visualize a concept, technique, idea, or natural phenomenon, and are great ways to motivate or introduce a topic. A good demonstration should make use of some motivational technique, including models, mock-ups, specimens, objects, pictures or photos, videos, computers, or films. Unlike an experiment, a demonstration is usually done by one person in front of the group. It is often used to show something for impact or when there are not enough materials to allow each person to "try it" themselves. Sometimes, you might choose a demonstration because it is too tricky or risky for each student to do individually.

When doing a demonstration, think about how to increase the impact by using bright colors, interesting sounds, or other eye and ear catching techniques and make sure everyone in the room can see what you're doing. We've included a sample demonstration, showing how much fresh water exists in the world. By adding a drop of blue food color to the water, this demonstration is much easier to see in the back of the room. Of course, it always helps to practice a demonstration a few times before you do it in front of a group so that you know it will be successful. You might also want to jot down some stimulating questions beforehand so that you don't have to think about what direction you want the discussion to take while you're concentrating on the demo.

We've also included two additional demonstrations: one focusing on the resources needed to produce the products we use and the other showing how coral polyps build reefs. The coral demonstration can be used with other activities to create a lesson plan that explains the natural history of coral reefs and leads into associated environmental problems and solutions.

ACTIVITIES IN THIS SECTION

1. **OUR WATERY WORLD** by Maura O'Conner. From *Living Lightly on the Planet—Volume 1.* Used with permission through arrangement with Schlitz Audubon Center of the National Audubon Society, 1111 East Brown Deer Road, Milwaukee, WI 53217. Copyrighted material. All rights reserved.
2. **KEEP ON TRUCKIN'**, reprinted with permission from *Project Learning Tree,* published by the American Forest Council and the Western Regional Environmental Education Council, 198X
3. **HOW DO POLYPS BUILD REEFS?** reprinted with permission from *Coral Reefs: Materials and Activities for Teaching Middle Grades,* produced by World Wildlife Fund and RARE, Inc. as part of the Caribbean Environmental Education Program, a project funded by the United States Agency for International Development.

OUR WATERY WORLD

OBJECTIVES:
Diagram the water cycle. Explain why the supply of water on earth is finite. Describe the breakdown of fresh and salt water on earth.

AGES:
All

SUBJECT:
Science

MATERIALS:
Diagram of the water cycle, one clear gallon container and two small clear jars

Photographs of Earth taken from the perspective of outer space reveal a watery world. This image coincides with a commonly held conception of water abundance. Ours is a water-rich planet. Problems we encounter with water shortages arise due to unequal distribution and unwise use of this life-sustaining resource. This investigation begins with a study of the water cycle. Students will see that the water we use on Earth today is the same water that filled the water jugs of the ancient Egyptians. Water moves in a closed system with no additional inputs from the atmosphere. We will never have more water on Earth than we have today.

THE WATER CYCLE

Start this activity by discussing the cycling of water on earth. The immensity of the cycle is illustrated in the following figures. (Help your students visualize the size of a cubic mile before discussing these figures. For example, eight city blocks equal one mile. Students could try visualizing a cube eight city blocks in length, width, and height.)

- At any given moment, an average of 3,100 cubic miles of water droplets and water vapor is distributed throughout the atmosphere.
- Once every 12 days all of the moisture in the air falls as precipitation and is subsequently replaced.
- Ninety-five thousand cubic miles of water are evaporated into the atmosphere annually: 80,000 from oceans and 15,000 from land.
- This is balanced by 95,000 cubic miles of precipitation that fall back to the Earth.

After reviewing the diagram of the water cycle on page 216 and discussing these figures, ask your students to diagram the global water cycle using arrows and labels to explain how the cycle flows.

WHERE THE WATER IS

In the face of such water abundance, why are there water shortages? The breakdown of fresh and salt water on the planet is outlined on the top of the next page.

(Reprinted from Living Lightly on the Planet—Voume 1, Schlitz Audubon Center.)

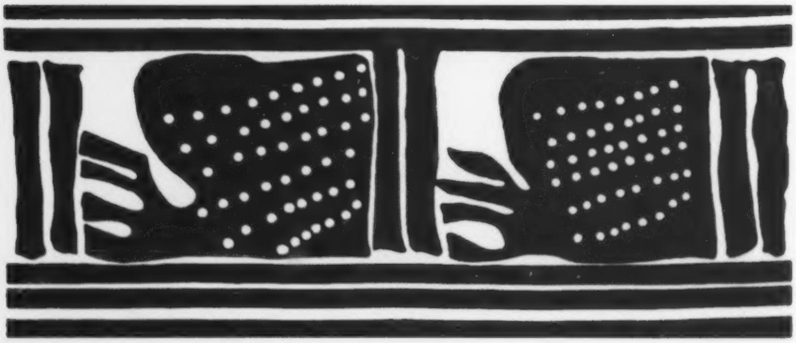
DISTRIBUTION OF EARTH'S WATER

LOCATION		PERCENTAGE
Ocean		97.3
Fresh		2.7
Distribution of fresh water:		
ice caps and glaciers	77.2	
groundwater and soil moisture	22.4	
lakes and wetlands	0.35	
atmosphere	0.04	
stream channels	0.01	

Source: Water Management for Arid Lands In Developing Countries, A. K. Biswas et al, p. 10

The following demonstration could be used to help your students conceptualize the breakdown of fresh and salt water. Fill a large, clear container with 100 ounces or 12½ cups of water. This represents 100% of the Earth's water. Pour 3 ounces into a small, clear container to roughly the percentage of fresh water on the planet. From the three-ounce container, pour 2¼ ounces into a third container. This represents the amount of water in ice caps and glaciers. The water remaining in the second container represents the percentage of water available for our use. You might want to label the containers beforehand so students can refer to the labels as you demonstrate.

If you wish to use metric units in the demonstration, begin with three liters of water to represent the Earth's total water. Then pour 90 milliliters into a second container to represent the percentage of fresh water. From the 90 milliliters, pour off 67½ milliliters into a third container to represent the amount of water in ice caps and glaciers. The amount remaining in the second container represents the amount available to us for fresh water uses.



(Reprinted from Living Lightly on the Planet—Voume 1, Schlitz Audubon Center.)

KEEP ON TRUCKIN'

OBJECTIVE:
Trace forest products from the forest to the consumer and back again to the forest.

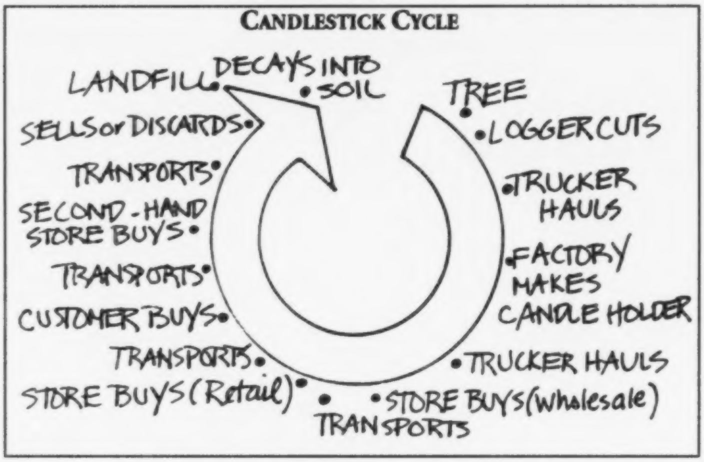
GRADES:
Intermediate, advanced

SUBJECTS:
Science, social studies, math, language arts

MATERIALS:
Sample products (optional)

Ask each student to bring to class three items that are products of the forest ecosystem. These need not be wood products; they may be buckskin gloves from deer or wool clothes from sheep that lived or grazed in the forest.

Ask each student to choose one of the items to research, identifying all of the steps necessary to produce the finished product from the raw material. Also ask the students to identify all of the steps necessary to "recycle" the finished product back to the forest. Ask the students to draw and label the points in the product's cycle-of-life on a large sheet of paper or on a chalkboard. For example:


CANDLESTICK CYCLE
LANDFILL
DECAYS INTO SOIL
TREE
SELLS or DISCARDS
LOGGER CUTS
TRANSPORTS
TRUCKER HAULS
SECOND-HAND STORE BUYS
FACTORY MAKES CANDLE HOLDER
TRANSPORTS
CUSTOMER BUYS
TRANSPORTS
TRUCKER HAULS
STORE BUYS (Retail)
STORE BUYS (Wholesale)
TRANSPORTS

When your students have completed their cycle diagrams, discuss:

- How many different times was the item transported? By truck, rail, car, boat, barge, or other means?
- How dependent are consumers of forest products on the energy required to transport the processed goods?
- Is it a simple or complex job to recycle forest products back into the forest? Why?
- Do the items each of you brought often get reused by a second person? Do these items often get recycled back to the forest? Do you think they should be returned? Why?
- What might you do to increase the chances of these items being reused or recycled? (Perhaps give them to a service agency such as Goodwill Industries or the Salvation Army.)

VARIATION

The United States consumes approximately 24 percent of its energy transporting products and people from one place to another. These products and people may be moved by any one of several carriers, each of which consumes a different amount of energy. Ask your students to use the information supplied in the tables to develop two resource cycles, one which expends the least amount of energy and one which uses the most. Through research and class discussion, compare these two cycles with reality.

- Which cycle most nearly corresponds to what happens in real life? Is it the most energy-efficient cycle possible?
- How much energy (in BTUs or calories) could be conserved by changing to more efficient modes of transportation? Once this has been determined, students might develop and submit energy conservation suggestions to a local company that deals in the product "cycled."
- What could the students do to make the cycle more energy efficient.

Suggest that they try some of their ideas. Follow in a few weeks with additional discussion in order for the students to consider and share their results.

TABLE I
ENERGY EFFICIENCY OF PASSENGER TRANSPORT

(Source: E. Hirst, Oak Ridge National Laboratory)

	BTU(1) CONSUMED/PASSENGER MILE	
ITEM	**URBAN**	**BETWEEN CITIES**
Bicycle	200	— —
Walking	300	— —
Buses	3,700	1,600
Railroads		1,900
Automobiles	8,100	3,400
Airplanes		8,400

(1) 1 BTU (British Thermal Unit) is equal to about 252 calories, which is equivalent to drinking about 1/2 of a malted milk.

TABLE II
ENERGY EFFICIENCY OF FREIGHT TRANSPORT

(Source: E. Hirst, Oak Ridge National Laboratory)

ITEM	**BTU CONSUMED/TON/MILE**
Pipeline	450
Railroad	670
Waterway (ship or barge)	680
Truck	3,800
Airplane	42,000

HOW DO POLYPS BUILD REEFS?

OBJECTIVES:
Explain the role of polyps in transforming calcium carbonate from seawater to coral reef skeletons. Define the terms: solid, liquid, gas, and solution. Name at least two other coral reef organisms that extract calcium carbonate (limestone) from seawater.

AGES:
Intermediate, advanced

MATERIALS:
Two glasses or jars; one tablespoon each of flour and sugar; spoon, or stirrer of some kind; balloon; one cup vinegar; one stick white chalk; six teaspoons baking soda; two clear glass containers, 250-300 ml (one cup); one clear glass container, 500 ml (two cups); small paper bag and hammer (or flat rock); marker for glasses (grease pencil, magic marker, or paper labels); chalkboard.

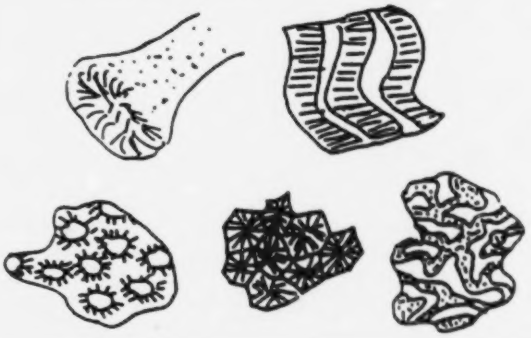
This activity requires two 45-minute to one-hour periods, a day apart. It uses a chemistry demonstration to teach about the production of coral skeletons. The demonstration shows students that under certain conditions, solid materials can be extracted from solutions. The source of coral reef skeletons, and therefore reef rocks themselves, is material (calcium and carbonate ions) dissolved in seawater.

The chemical reaction demonstrated here is not the same reaction that occurs in the coral polyp, especially within the algae of its stomach lining. The only purpose of the demonstration is to show that solids can be produced from dissolved substances—as happens in coral polyps. We imitate rather than duplicate the events in coral.

The actual events within coral involve a subtle series of equilibrium reactions:

- Ocean water bears enormous amounts of dissolved limestone (calcium carbonate, or $CaC0_3$), just as we know that it also carries enormous amounts of table salt (sodium chloride, or NaCl). Unlike sodium, calcium combines with carbonate ions to form a relatively insoluble substance, calcium carbonate. This happens only when slight acidity is present.
- Within coraline algae, the correct acid conditions occur for the formation of calcium carbonate. Calcium carbonate is relatively insoluble in water, so it forms a solid and precipitates out. Within the polyp, calcium carbonate is transported from the algae to the polyp's base. There it is laid down in the particular pattern characteristic of that species of coral.

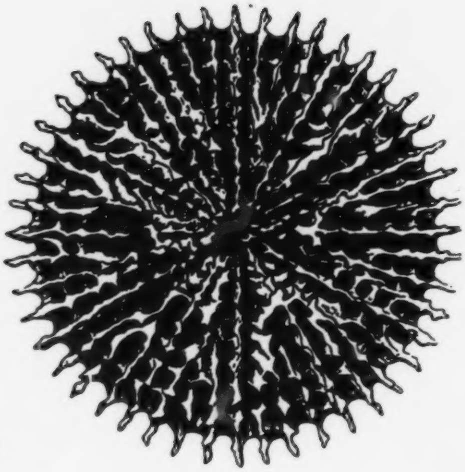
SKELETON PATTERNS OF DIFFERENT CORALS



This reaction is extremely important. Many animal shells, bones and teeth consist primarily of limestone. Major rock formations at the bottom of the sea consist of the same substance. Important limestone beds on land once originated in this way.

Human teeth and bones also consist of calcium carbonate. In fact, a parallel of this activity's demonstration takes place when we do not brush our teeth. Bacteria build up in food deposits on our teeth. They produce mild acids that dissolve the calcium carbonate—just as in the demonstration, vinegar dissolves chalk. The result in our case: dental cavities.

Your students may notice that chalk, teeth, and coral possess different textures, despite being of the same chemical. The students would be correct; calcium carbonate solids are deposited in several ways. Geologists say that each of these is a different mineral, and call each by a different name. Collectively, though, all are forms of calcium carbonate, or limestone. But each mineral acquires its particular texture, hardness, and crystal structure under particular pressures, water availability, and other factors. The limestone mineral we are talking about here is called aragonite.



STUDENT BACKGROUND

Without its skeleton, a coral polyp would be just a soft, fleshy little animal. But with its skeleton, the polyp is something like a turtle—an animal with a sturdy, built-in shelter. Millions of these rocky shelters eventually add up to tons and tons of coral reef rock. How, you may wonder, does the polyp build its skeleton? And where does the material to build the rocky skeletons come from?

If you have seen coral rocks, perhaps on the beach, you probably remember that they are white, and harder than cement. You know where cement comes from—a builder mixes it with water and then pours it to harden into bricks, foundations, and other parts of buildings or roads. You also know that nobody took cement out to any coral reef. So where does the rock come from?

Coral reefs grow through two processes. First, baby polyps grow from mature polyps. The second process of coral reef growth is the slow build-up of rock underneath the polyps. To understand how this is done, first think about the types of substances around us—and reefs.

There are four types of substances: solids, liquids, gases, and solutions.

You probably know about solids. These are "hard" substances—they stay in one place, have a definite shape, and take up a definite amount of space most of the time. Can you point to a solid? (Pick one, and pass it around. Discuss how it matches the description.)

The second kind of substance is a liquid. These are fluid substances. They occupy a definite amount of space, but take the shape of whatever container they happen to be in. Can you name some liquids? (*Discuss*)

Then there are gases. Gases fill up their containers taking all the space they can get. They do not have any particular shape either. The air we breathe is a mixture of several gases. Oxygen, nitrogen, and carbon dioxide are the most important. (Dip a piece of cloth in liquid ammonia. Wave the cloth around. Tell students that ammonia gas is mixing with air gases. Ask students to raise their hands when they smell the ammonia. Explain that the ammonia will continue to expand until it is all over the room.)

Finally, there are combinations of different solids with solids, liquids with liquids, and gases with gases. These we call solutions. We are most familiar with solutions of solids in liquids. What happens when you stir sugar into water? Or salt in your soup? (*Discuss.*) Unless you put in too much, the sugar or salt—which are solids—just disappear, don't they? We call this process dissolving.

You know the sugar or salt are still in the water somewhere because you can still taste them. But you cannot see them any more. Dissolving sugar in water is very different from mixing flour and water. With flour, no matter how much water you add, you will still be able to see tiny white specs of flour—each consisting of millions of molecules of flour solids— in the water. What you have is just a *mixture.*

(Demonstrate with a tablespoon of flour in a jar of water, and a tablespoon of sugar in another. Ask two students to stir or shake the jars for one minute. Then pass the jars around. Discuss the differences observed in the two jars. Ask whether the flour specs tend to settle to the bottom. They will. Note that in the sugar solution, the sugar does not settle out.)

The sugar and water jar contains a solution—the product of two or more substances truly dissolving.

Now imagine that you could see the smallest possible "pieces" of water—scientists call them water molecules. If you could see water molecules, they would be moving about, with empty spaces among them. When you put sugar in water, the sugar molecules slip into these empty spaces. They become part of the liquid, unlike the flour.

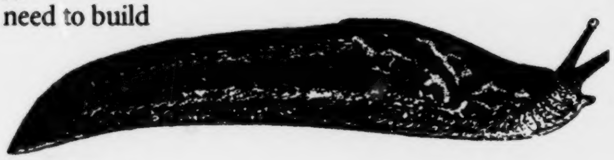
Now, let us go back to the original question of how coral polyps build reef rock. Sea water has many substances dissolved in it. You know one of them probably, by the taste of seawater. Can anyone name this solid? . . . (*question*) Yes, salt.

Another substance dissolved in sea water is a type of rock called limestone—a chemical called calcium carbonate. Inside coral polyps, something happens to this dissolved limestone. Algae living inside the polyp can change limestone from being dissolved in a liquid to being a solid. The polyp takes this solid and lays it down underneath its body, thus creating its skeleton.

Many plants and animals use limestone in their bodies. You do too. Do you know where? (*Discuss*) If you said your teeth and your bones are made of calcium carbonate, you are right. On a reef, snails and clams also use calcium carbonate to build their shells, while fish use it in their bones.

Coral reefs build up tons and tons of limestone, sometimes building whole islands, and lining the ocean bottom near the shore. Millions of years later, these deposits of limestone may rise and become land. Today, limestone is a valuable mineral, used for the construction of buildings and for many other processes. The creation of limestone is a very important process in nature.

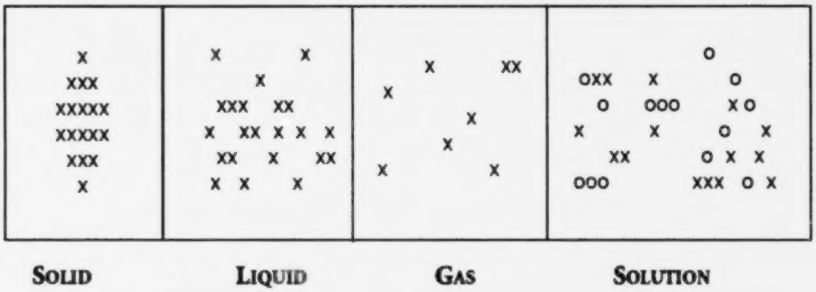
Today's science demonstration will show you the change of dissolved limestone into solid limestone—something like the process that happens when a coral polyp forms its skeleton. The process you will see is much simpler than what really happens in a polyp. But it will help you understand where polyps get the limestone they need to build their skeletons and coral reefs.



PROCEDURE: PART 1

1. At the beginning of class, write on the chalkboard, "Where does coral reef rock come from?" Tell the class that this is the problem for the day. Ask students if they have any ideas. Write what they come up with on one side of the chalkboard.
2. Write four words on the chalkboard: Solid, Liquid, Gas, Solution. Read "Student Background" aloud, discussing as you go along. To illustrate the differences among solids, liquids, and gases, it might be helpful to draw these sketches on the blackboard:

   (The **x**'s and **o**'s represent molecules of a substance.)



3. Begin the demonstration by breaking the piece of chalk into pieces. Ask a student volunteer to help. The student should put the chalk in a paper bag and bang it gently with a hammer. This should be done until the chalk is reduced to small pieces and powder.
4. Explain that chalk *is* limestone, or calcium carbonate. Unlike sugar, it dissolves very slowly in water. You are going to dissolve it in vinegar to speed up the dissolving process. (Vinegar is a solution of water and the weak acid, acetic acid.)
5. Pour 250 ml vinegar into a glass. Pour the chalk pieces into the vinegar and stir.
6. Tell the class that you will let the chalk/vinegar preparation sit overnight. (Meanwhile, stir the chalk/vinegar preparation occasionally.)

PROCEDURE: PART 2 (THE FOLLOWING DAY)

7. When you return to the demonstration, show students that much of the chalk has disappeared. It has dissolved in the liquid. Tell students that sea water acts much like this solution, except that seawater has dozens of dissolved solids in it. They already know that salt is one, but others, including gold, are dissolved in the sea.

8. Label two clear glasses. The 500 ml (two cup) glass should be "dissolved limestone," and the 250 ml (one cup) glass should be "dissolved baking soda."

9. Into the glass marked "dissolved limestone," carefully pour off the clear liquid from the chalk/vinegar solution.

10. Into an unlabeled glass, pour 250 ml (one cup) of water. In it, dissolve the 6 teaspoons of baking soda. Ask a student to stir it for about 15 minutes, or until no trace of solid remains. While doing this, tell students that you are dissolving sodium bicarbonate in this glass of water. Let any remaining solid settle for a few minutes, then pour the clear liquid into the glass labeled "dissolved baking soda."

11. Ask a student volunteer to mix the two solutions. Alert the class to watch closely. What they see will be similar to what happens to seawater when it comes in contact with algae in coral polyps. The student should slowly pour the dissolved baking soda into the dissolved limestone.

12. Students will observe white particles of solid calcium carbonate appear in the clear liquid. Pass the glass around, so that students can see the fine, white powder at the bottom of the glass.

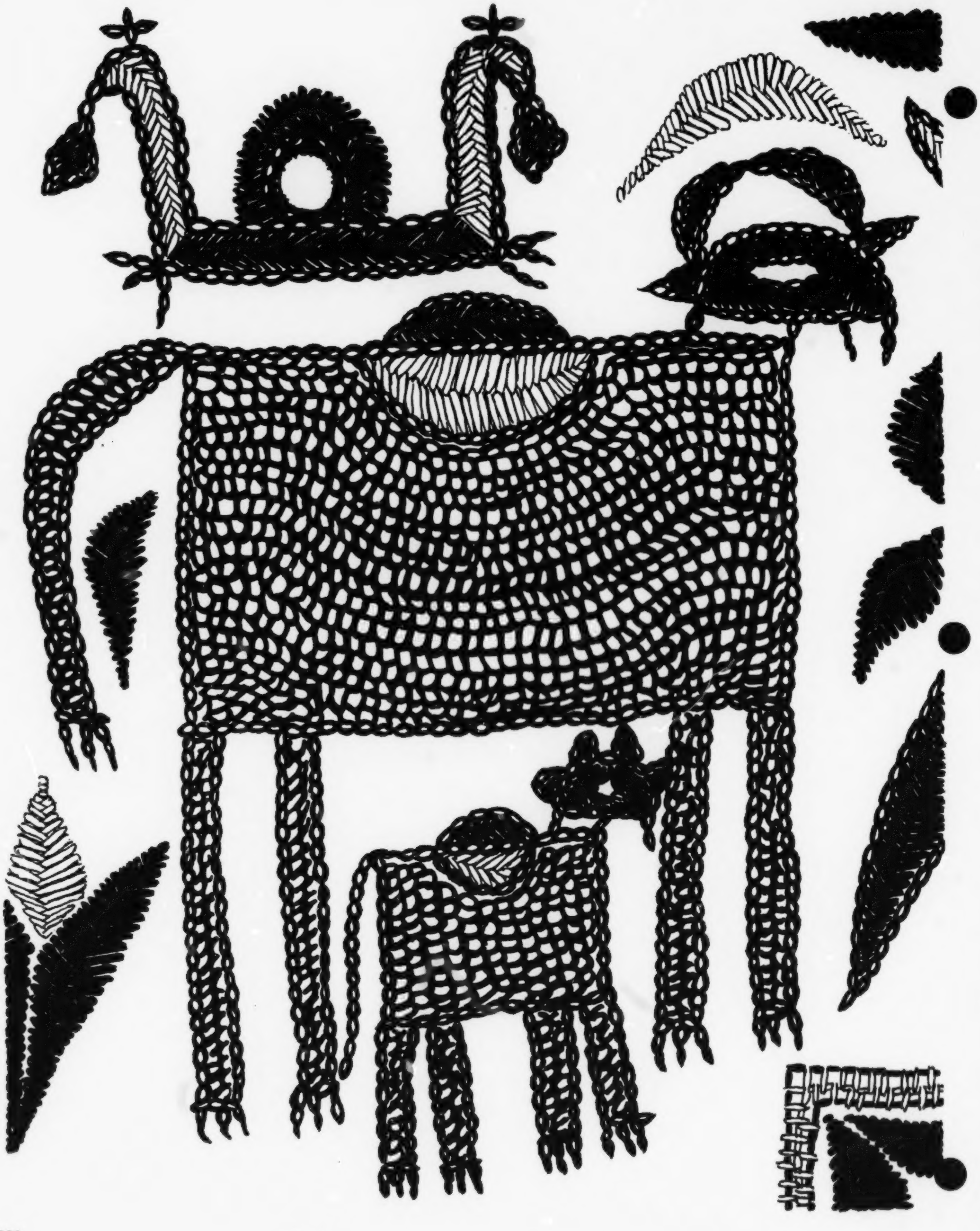
13. Discuss the process with students, making sure that they understand what they have just seen.

14. Explain to students that once the calcium carbonate is formed by algae within the polyp, the polyp's body transports it downward and secretes it as skeleton. However, the mineral is laid down in a tight crystal formation, rather than as loose particles— as they saw in the demonstration. Also, each type of coral lays down limestone in different shaped skeleton "cups."

    In this way, layer upon layer of calcium carbonate build up over the years. Corals build one to two centimeters of skeleton per year.

15. Without algae inside their bodies, polyps would be unable to build up enough skeleton. Explain this to students. Ask them what would happen if a coral polyp settled in very deep water, below the depth reached by sunlight. (They could not build reefs because algae, like all plants, must have sunlight.)

16. Ask students to write two or three paragraphs summarizing what they saw in the demonstration, and how the demonstration resembles the skeleton-building process of corals.



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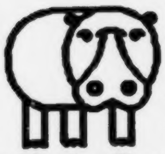


9.

INVESTIGATIONS AND EXPERIMENTS

What's the best way to clean up an oil spill? How does acid rain affect plants? How does salt from over-irrigation affect plant growth? Conducting investigations can help students answer questions like these about the environment, and it can also help them develop thinking skills, such as how to form a hypothesis, gather data, interpret data, recognize differences and similarities, and draw conclusions. Most of us limit investigations and experimentation to the science classroom, but you can have your students conduct investigations in a variety of subject areas, including social studies, health, and history. (For more about conducting scientific experiments, see *Science Teacher's Handbook*, ICE, Manual R-50, Peace Corps.)

An investigation can be structured (a controlled experiment that follows the scientific method) or more informal. For example, your students can design and carry out a structured experiment to see if acid rain harms plants or if birds prefer certain foods. Or you can have your students investigate how waste is treated in the community, how people feel about a new incinerator, or what types of plants and animals live in a local wetland. Through investigations, your students can practice collecting data, analyzing results, and drawing conclusions.

We've included two activities that focus on experimentation and investigation. The first activity includes six mini-experiments focusing on the causes and consequences of acid rain. The second encourages students to find the best way to clean up an oil spill by experimenting with several different methods.

ACTIVITIES IN THIS SECTION

1. **ACID TESTS**, reprinted with permission from *Ranger Rick's NatureScope: Pollution—Problems and Solutions,* published by the National Wildlife Federation, 1990.
2. **HOW CAN AN OIL SPILL BE CLEANED UP** by Stephanie Ihle and Rosanne Fortner. Published by the Ohio Sea Grant Education Program, Ohio State University Research Foundation, 1987. (Teacher Guide, EP-12, Act)

ACID TESTS

OBJECTIVES:
Give an example of an acid and a base. Explain why some soils are not affected by acid rain as much as others. Describe how acid rain can affect plants, animals, and buildings and other structures. Discuss some methods that can help reduce the effects of acid rain.

AGES:
Intermediate, advanced

SUBJECT:
Science

MATERIALS:
Chalkboard or easel paper, copies of the demonstrations on pages 236 and 237 (see demonstrations for additional materials)

Your kids can do some demonstrations to learn about how acid rain affects the environment. Start the activity by explaining to the kids how acid rain forms (see the background information in *NatureScope Pollution—Problems and Solutions*). Then give each person a copy of "Acid Demonstrations" on pages 236 and 237. Tell the kids that by doing several demonstrations, they'll learn more about the effects of acid rain. The first demonstration will help them learn about the pH scale.

Explain that the pH scale is a simple way to measure the relative acidity of a substance. The scale ranges from 0 to 14. A solution with a pH of 1 is very acidic, while one with a pH of 12 or 13 is very basic, or alkaline. A solution with a pH of 7 is considered neutral. For example, rain water, which is normally slightly acidic, averages between 5.0 and 5.6. The pH scale is logarithmic, which means that there is a tenfold difference between numbers. A solution that has a pH of 4 is about 10 times more acidic than a solution with a pH of 5.

Also explain to the kids that they'll be using specially treated pH paper to measure the acidity of different liquids. When they dip the paper into a liquid, it will turn a certain color. They should immediately match this color to a color chart to find out the pH. You might want to take the pH of one of the liquids listed in demonstration 1 (on page 236) as a group to make sure the kids understand how to use pH paper. (Note: Although pH paper is not the most accurate measurement of acidity, it does measure relative acidity, which is what's important for these demonstrations.)

Next divide the kids into small groups and have them do demonstration 1. Afterward copy the names of all the test solutions on a chalkboard or sheet of easel paper and have the groups fill in their results so the kids can see what the other groups came up with. Then, once the kids understand the pH scale, have them tackle the other demonstrations. You may want to have the kids work in teams to do all the demonstrations, or you can have the members of each team do one demonstration and later explain their results to the group. Also have the kids write down their answers to "What Happened?" and "Think About It" so they can discuss each demonstration later. See the information under "Acid Test Follow-up"on pages 238 and 239 to add to your discussion. You might also want to have the kids point out the control in demonstrations 2-5.

SUPPLY TIPS

- You can order pH paper from biological supply companies, including Carolina Biological Supply, 2700 York Rd., Burlington, NC 27215, 800-334-5551. Be sure to order wide-range (1-12 or 0-14) pH hydrion paper. You'll need 4 or 5 rolls for a group of 25.
- You can get powdered lime, potting soil, and sphagnum moss at nurseries and garden stores. Be sure that the potting soil you get has a pH of around 6. You might want to buy a soil pH test kit to check the pH of the potting soil.
- Be sure to buy chalk that has calcium carbonate in it.
- Use reusable or recyclable containers for the demonstrations.

SAFETY TIP

- Caution the kids to avoid getting the powdered lime near their eyes or mouth. Also be sure to have them wash their hands after doing the demonstrations.

ACID DEMONSTRATIONS: PART I

1. SETTING UP THE SCALE

WHAT YOU'LL NEED: pH paper, 10 small containers. masking tape, markers, vinegar, lemon juice, tap water, milk, cola soft drink, coffee, distilled water, liquid antacid, baking soda and water solution (1/4 teaspoon baking soda in 2/3 cup water), powdered lime and water solution (1/4 teaspoon lime in 2/3 cup water)

WHAT TO DO:

1. Place a small sample of each liquid in a separate container. Label each container with the name of the liquid, using masking tape and a marker.
2. Test the pH of each liquid by dipping a 1-1/2" piece of pH paper in the liquid. Be careful to throw away the used pH paper, since it can stain desktops and other surfaces. Also be sure to use a new strip of pH paper each time you test a liquid. Record the pH for each liquid.

WHAT HAPPENED?

List the liquids in order from most acidic to least acidic. Compare your results with those of the other groups.

THINK ABOUT IT

Did everyone get the same answers? If not, why do you think some of your answers differed?

2. TO GROW OR NOT TO GROW

WHAT YOU'LL NEED: Seeds (radish, clover, pea, or mustard seeds will work best), large container, distilled water, 20 empty pint milk cartons, potting soil, marker, masking tape, vinegar, ruler, measuring cup, pH paper

WHAT TO DO:

1. Fill the 20 milk cartons three-quarters full with potting soil. Plant one seed in each carton.
2. Label 10 of the cartons with "A" for acid and 10 with "DW" for distilled water.
3. Make a solution with a pH of about 3 by mixing 1 cup of vinegar with 4 cups of distilled water.
4. Measure the pH of the distilled water and record it. Then water the seeds in the cartons labeled "DW" with distilled water and the seeds in the cartons labeled "A" with the acidic solution. Put the cartons in a sunny spot indoors.
5. Over the next three weeks or so, water all the seedlings with the appropriate kind of water whenever they look dry. Make sure you give each seedling the same amount of water. Record the date each seed sprouts and also measure the heights of the seedlings every few days.

WHAT HAPPENED?

Which seedlings grew the most? Which grew the least?

THINK ABOUT IT

Why was it important to keep the seedlings indoors instead of letting them grow outside? Why do you think you were told to water more than one seed with each solution? If acid rain has about the same acidity as the acid solution you used, how might it affect plant growth?

3. THE BIG CHILL

WHAT YOU'LL NEED: 2 ice cube trays, distilled water, lemon juice, freezer, pH paper, 2 containers, marker, masking tape, measuring spoon and cup

WHAT TO DO

1. Take the pH of the distilled water and record it. Then pour enough distilled water into an ice tray to make 3 ice cubes. Label the tray "DW" for distilled water and put it in the freezer.
2. Add 1-1/2 teaspoons of lemon juice to 2/3 cup of distilled water to make a solution with a pH of 3. Pour enough of the lemon-juice solution into an ice tray to make 3 ice cubes. Label the tray with "A" for acid and put it in the freezer.
3. Once the ice cubes have formed, pour the same amount of distilled water (about 3 cups) into each container.
4. Put the 3 distilled water ice cubes into one of the containers and let them melt. Then put the 3 ice cubes made from the acidic solution into the other container and let them melt.
5. After the ice cubes melt, stir both solutions. Then take the pH of the liquid in each container and record the results.

WHAT HAPPENED?

What was the pH of the water in each of the containers after the ice cubes melted?

THINK ABOUT IT

In some areas, acid snow falls during the winter. In early spring, the snow that has fallen throughout the winter melts and runs into lakes and streams. Using the results of this demonstration, how might the acidic snowmelt affect the pH of lakes and streams? What other effects might this change in pH have?

ACID DEMONSTRATIONS: PART II

4. CHALK TALK

WHAT YOU'LL NEED: pH paper, lemon juice, distilled water, 2 equal sized pieces of chalk, 2 small containers, paper clip, masking tape, marker, measuring cup and spoon

WHAT TO DO:

1. Take the pH of the distilled water and record it.
2. Make up a solution with a pH of 3 by adding 1 and 1/2 teaspoons of lemon juice to 2/3 cup of distilled water.
3. Unbend a paper clip, and then use it to carve a line in one piece of chalk. Place the chalk in one container and add enough acid solution to cover the chalk. Observe and record what happens, and then label this container "A" for acid.
4. Carve an identical line in the other piece of chalk, and then place it in the other container. Add enough distilled water to cover the chalk. Observe and record what happens, and then label this container "W."
5. Let the chalk remain in the solutions for 24 hours.
6. When the 24 hours are up, pour out the liquids and take a close look at each piece of chalk.

WHAT HAPPENED?

Is there any difference between the two pieces of chalk? Explain your answer.

THINK ABOUT IT

Many statues and buildings are made from marble. Marble is made up of the same minerals as chalk is, but it's harder than chalk. Using the results of this demonstration, what do you think could be happening to marble statues and buildings that are located in areas where acid rain falls?

5. SOIL STUFF

WHAT YOU'LL NEED: sample of soil from your area, potting soil, sphagnum moss, paper, vinegar, distilled water, measuring cup, large container, pH paper

WHAT TO DO:

1. Make up a solution with a pH of about 3 by adding 1 cup of vinegar to 3 cups distilled water. Record the pH.
2. Put a piece of filter paper into a funnel, and then fill the funnel about two-thirds full with the sphagnum moss.
3. Put the funnel over a large container, and then pour the acidic solution into the funnel (make sure you don't add too much liquid all at once). Wait until all the liquid has collected in the container below the funnel.
4. Take the pH of the liquid that collects in the container.
5. After rinsing out the funnel and container and removing the used filter paper, repeat the experiment twice using potting soil instead of sphagnum moss and then using the soil from your area. (Be sure to rinse the equipment between uses.)

WHAT HAPPENED?

Did the pH of the liquid change after you poured it through the sphagnum moss? The potting soil? The soil from your area?

THINK ABOUT IT

Based on your results, what do you think would happen if you added a small amount of lime to the soil from your area, and then poured some of the acidic solution through it? In some areas where acid rain falls, lakes and streams don't show the effects of acid rain. But in other areas where acid rain falls, lakes and streams have become acidified. Based on the results of this demonstration, why do you think these differences exist?

6. BACK TO BASICS

WHAT YOU'LL NEED: tap water, pH paper, container, vinegar, measuring spoon, baking soda, powdered lime, vinegar or lemon piece, distilled water

WHAT TO DO:

1. Put some tap water in a container and measure the pH.
2. Add a small amount of vinegar to the water and measure the pH again. Keep adding vinegar until the solution has a pH of 4.
3. What could you do to return the pH of the water to its original pH? (Think about the substances you tested in demonstration 1.) Your goal is to "fix" the pH by adding only a small amount of one substance.

WHAT HAPPENED?

Did your experiment successfully return the solution to its original pH? Describe what you did.

THINK ABOUT IT

Using the results of this demonstration, what are some steps you might take to decrease the acidity in an acidic lake? What kinds of problems might this action cause?

ACID TEST FOLLOW-UP

1. Lemon juice—2, vinegar— 2 or 3, cola soft drink—4, coffee—5, tap water—5, milk—6, distilled water—6 or 7, baking soda and water—7, liquid antacid—9 or 10, lime and water—12. Some kids might have gotten different pH readings because they interpreted the colors on the pH scale differently or because there were variations in the pH paper.

2. The seeds watered with distilled water should have sprouted first and grown the most. The seeds watered with the acidic solution should have sprouted later or not at all. (If they did sprout, they might have had yellowed and/or stunted leaves.)

   The plants were kept inside to keep rainwater from affecting the results of the experiment. Watering several seeds with each type of solution reduced the likelihood of any one seed skewing the results because of disease or other problems.

   The kids should have come up with the idea that acid rain (represented by the vinegar-and-water solution) can negatively affect plant growth. Be sure to point out to the kids that the vinegar solution only simulates the acidity of acid rain. Since vinegar contains substances that are not found in acid rain, the growth of the seeds may have been influenced by the other ingredients in vinegar, as well as by the acid in the solution. Also point out that acid rain is rarely as acidic as the solution used in this demonstration. (Acid rain generally has a pH of about 4.)

   Scientists think that acid rain doesn't significantly affect most crops, since these plants are exposed to acid rain for a relatively short time and because the soil they grow in is usually limed to reduce acidity and fertilized to replenish nutrients. But some scientists think that acid rain may affect trees (which are longer lived and can be exposed to acid rain for many years) by weakening them and making them more vulnerable to stress. For example, acid rain may increase a tree's susceptibility to drought, disease, cold, and insect attack. Acid rain may also cause certain essential minerals in the soil to dissolve and wash out. Without these minerals, a tree may grow more slowly. These effects can be worsened when acid rain combines with other pollutants such as ozone.

3. The pH of the water should have become lower after the acidic ice cubes melted, while the pH of the water with the distilled-water ice cubes should not have changed.

   The surge of acidic water from sudden snowmelt (represented by the ice cubes made from the acidic solution) can cause a drastic drop in pH. This sudden jump in acidity (called "spring shock") can kill certain species of fish. Spring shock also interferes with the reproduction of fish and other aquatic animals. For example, most fish, salamanders, and frogs lay their eggs in the early spring—just about the time spring shock occurs. The eggs and young of these species are very sensitive to acidity and are often killed by the sudden increase in acidity. And if the eggs survive, the young that hatch may be deformed.

4. The kids should have noticed bubbling when they added the acid solution to the chalk. The bubbles formed as the acid in the solution reacted with the calcium carbonate in the chalk They should have seen much less bubbling when they added distilled water to the chalk. Overnight, the chalk in the acid solution should have partially dissolved, and the carved line should have become much less distinct. The chalk in the distilled water should have been less affected, and the carved line should not have changed much in appearance.

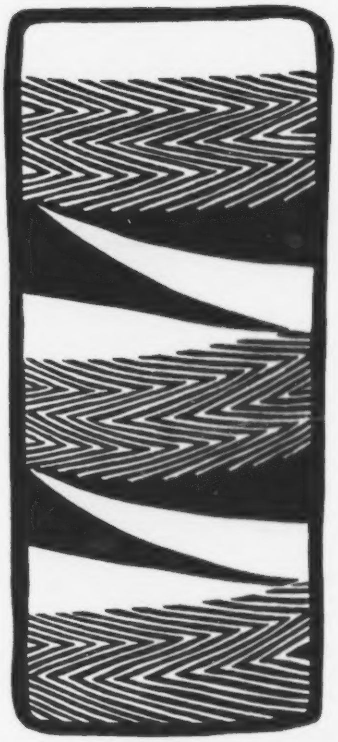
   As acid rain falls on marble structures, the acid slowly dissolves the marble. Be sure to point out that most rainfall isn't as acidic as the solution the kids made up in this demonstration. But over time, acid rain does erode buildings, statues, and other structures.

5. The pH of the solution poured through the sphagnum moss should have stayed the same. The solution poured through the potting soil should have become less acidic. Results for the soil taken from your area will vary, depending on the pH of

your soil. The potting soil, which is significantly less acidic than the solution, acted as a buffer; it neutralized some of the acid in the solution. The sphagnum moss is more acidic and didn't neutralize the acids in the solution. If the pH of the solution poured through the soil from your area remained the same, your soil is probably acidic; if the pH increased, your soil is probably alkaline.

If you added lime to your soil, the pH of the solution that drained through the funnel should increase. That's because adding lime to soil makes it more alkaline and helps it to neutralize the acidic solution.

Differences in soil types can help explain the varying effects of acid rain. In areas with deep, alkaline soils, acidic rainwater slowly trickles through the soil and is neutralized before it reaches lakes and streams. Other areas, such as some parts of New England and the Adirondacks, have thin, relatively acidic soils. Acid rain quickly runs into lakes and streams without being neutralized. Because of this, many lakes in these regions have become acidified.



6. The kids should have come up with the idea of adding lime or baking soda to the water to make it less acidic. (Lime will be most effective in small amounts, since it is more alkaline than baking soda.)

   In some areas, people have added lime pellets or powder to lakes to make them less acidic. Although this has been relatively successful in some cases, it is an expensive and short-term solution. If acid rain continues to fall, more lime will have to be added in a year or two. Scientists think that the best way to combat acid rain is to stop it at its source. Problems to consider include how adding lime or baking soda could affect aquatic life and how to figure out the correct amount of lime or baking soda to add.

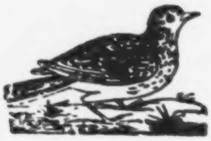
HOW CAN AN OIL SPILL BE CLEANED UP?

OBJECTIVE:
Discuss three ways in which oil may be removed from water.

AGES:
Intermediate, advanced

SUBJECTS:
Science

MATERIALS:
For each team of students: aluminum "pot pie" pan or butter tub, water, 10 ml of motor oil, 25-cm pieces of twine, handful of straw, alcohol burner matches, wooden splints, paper towels, liquid detergent, dropper, safety glasses, newspapers to cover working surfaces



The moment a spill occurs, nature begins cleaning up. The oil separates into heavier and lighter parts and is spread by wind and currents. Some of it evaporates, like gasoline spilled from the gas pump. Certain types of bacteria called petrophiles consume some of the oil. According to marine affairs specialist E. W. Seabrook Hull, "Within a couple of years no sign of the disaster remains. The oil is gone, and the birds and other marine life are back, as though nothing had happened. This has been shown in the case of Torrey Canyon, the Wafra, the Arrow, the Argo Merchant, Santa Barbara, and numerous other events."

The sight of oily birds and beaches and the loss of tourist and fishing income make us impatient with the slow dependable processes of a natural clean-up. An oil spill needs to be cleaned up right now, we think. But how can this be done?

PROCEDURES

Success in cleaning up an oil spill depends upon preparedness and rapid action by the spiller and by federal, state and local agencies. When a spill occurs, it is reported to the nearest U.S. Coast Guard station. The spiller, by law, is supposed to clean up the oil. If the spiller does not clean up the pollution, the Coast Guard takes over and the spiller pays the clean-up costs.

In this activity your team will create an oil spill and try various methods of cleaning it up.

Note: Information to teachers is enclosed in boxes in this activity.

I. CONTAINMENT

If an oil spill is contained in one area, cleanup is easier and less environmental damage is likely to occur. Containment must be done as soon as a spill is detected if it is to be effective.

1. Add about 2 cm of water to your pie pan or bowl to serve as a lake.

An oil tanker has sprung a leak in the middle of your "lake." Add 2 drops of oil to the water's surface.

Tie the ends of a piece of string together and gently place the circle of string on top of the water, with the oil inside. Slowly add 2 ml more oil inside the circle. Pull the oil to one side of the pan using the string.

Note: If any oil is spilled outside the pan, clean it up immediately. Spilled oil can cause unnecessary accidents.

2. Does the string keep the oil from spreading over the entire lake? This is how a "boom" operates to contain a spill.

T2. *The string should contain the oil. If too much oil is added, however, it will overflow the boom. You may want to adjust the amount of oil students add. For lighter oils, spreading is greater and you should decrease the amount used.*

3. Some contained oil can be reclaimed (collected for further use). Use a dropper to try to reclaim some of your oil. About how much oil were you able to reclaim?

T3. *Answers will depend on how thorough the students are. Most of the oil can probably be removed, but it will be mixed with water. Further treatment would be necessary before the oil could be removed.*

II. REMOVAL OF OIL FROM WATER

Whether the oil is contained or free, it still must be cleaned up to prevent further environmental damage. Although there are many elaborate techniques for oil removal, some simple and non-technical methods are still widely used.

A. REMOVAL BY BURNING

1. Remove the string from your lake. Pour 5 ml of oil on the water surface.
2. Put on safety glasses and light your alcohol burner. Set fire to the tip of a wooden splint. Try to ignite the oil spill with the burning splint.
3. Does the oil burn? If so, how long did it burn? Was there any oil left when the flames went out? If the oil did not burn, try to explain why.

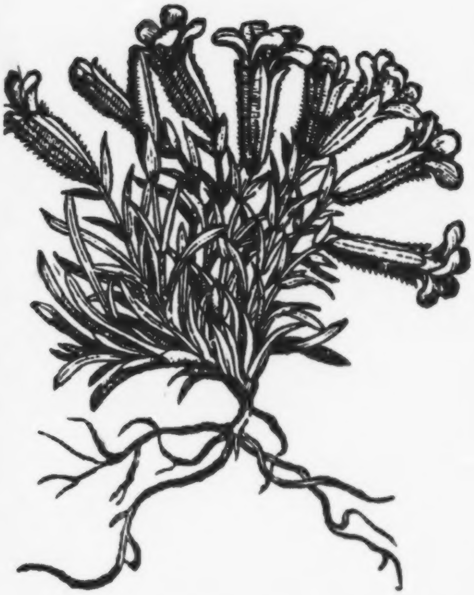
T3. *The oil should not burn. In trying to explain why, students may explain that "it is wet." In reality, the oil will not burn because it is a type that does not contain flammable substances. Petroleum fractions are separated with their uses in mind. Some contain volatile mixtures while others (like this oil) are mostly inert.*

4. If the oil is burned, what other damage to the environment might occur?

T4. *If the oil burned, damage might occur in the form of air pollution.*

5. Is the burning of the oil an effective way to clean up an oil spill? Explain.

T5. *No. Not all types of oil will burn, and if they do burn they could cause other environmental damage.*



B. Removal by Sinking

Ordinarily, oil floats on water because it is not as dense as water. Increasing the oil's density will make it sink to the bottom.

1. If your oil was cleaned up in Procedure A, add 5 ml of new oil to your lake.
2. Sprinkle enough sand on the oil spill to cause it to sink. Does this method remove all (or most) of the oil from the surface?

T2. *Most of the oil will sink when sand is added. However, if left standing the oil may escape and bubble to the surface again.*

3. When this method is used, what other effects will it have on the environment?

T3. *Bottom organisms could be smothered. Contaminants could be trapped in the bottom sediments so that future burrowing animals would be poisoned.*

4. What should you know about the water environment before using this method to clean up a real oil spill?

T4. *You should know what bottom organisms you would damage and whether the oil is light enough to surface again.*

5. Is sinking a good way to clean up an oil spill? Explain.

T5. *No. There is too much potential for damaging bottom organisms (such as shellfish) and no promise of permanent oil removal.*

C. Removal by ABsorption

Certain materials will attract oil to their own surfaces. This is called *adsorption*. You have probably seen pictures of this type of clean up method.

1. Pour 5 ml of new oil into your lake. (You do not need to dump the oily sand from B unless it is deep enough to break the water surface.)

2. Place a small amount of straw on top of the oil. What happens?

T2. *Oil sticks to all the surfaces of the straw.*

3. How can you remove the oil from the lake now? Check your idea with your teacher, and try the idea if the teacher approves. Did your idea work?

T3. *Picking up the straw or burning the straw are the most frequent suggestions. Both work fairly well, especially if clean straw is added and removed several times.*

Note: If students wish to burn the oily straw, this activity should be supervised outdoors. Black greasy smoke may result.

4. Is adsorption a good way to clean up an oil spill?

T4. *This is a better way than most, especially if the oily straw is mechanically removed instead of burned. In reality, the oily straw would probably be hauled to a landfill, where it will again be a contaminant.*

D. REMOVAL BY DETERGENTS

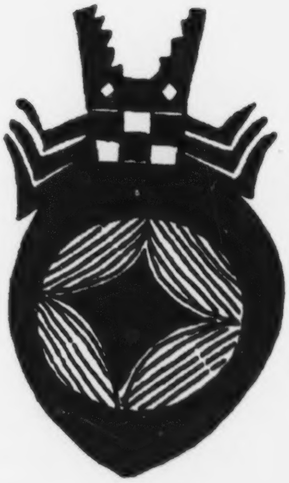
Household detergents are used to remove oil from laundry or grease from dishes. They do this by breaking up oil drops and dispersing them in the water to form an emulsion.

1. Dump the contents of your lake in the container provided by your teacher. Wipe the lake basin out and add fresh water.
2. Add one drop of oil and one drop of liquid detergent to the lake. Stir the two together vigorously with a wooden splint. What happens?

T2. *A milky suspension is formed. Neither drop is visible any more.*

3. Does dispersion by detergents let you clean up the oil easier? Explain.

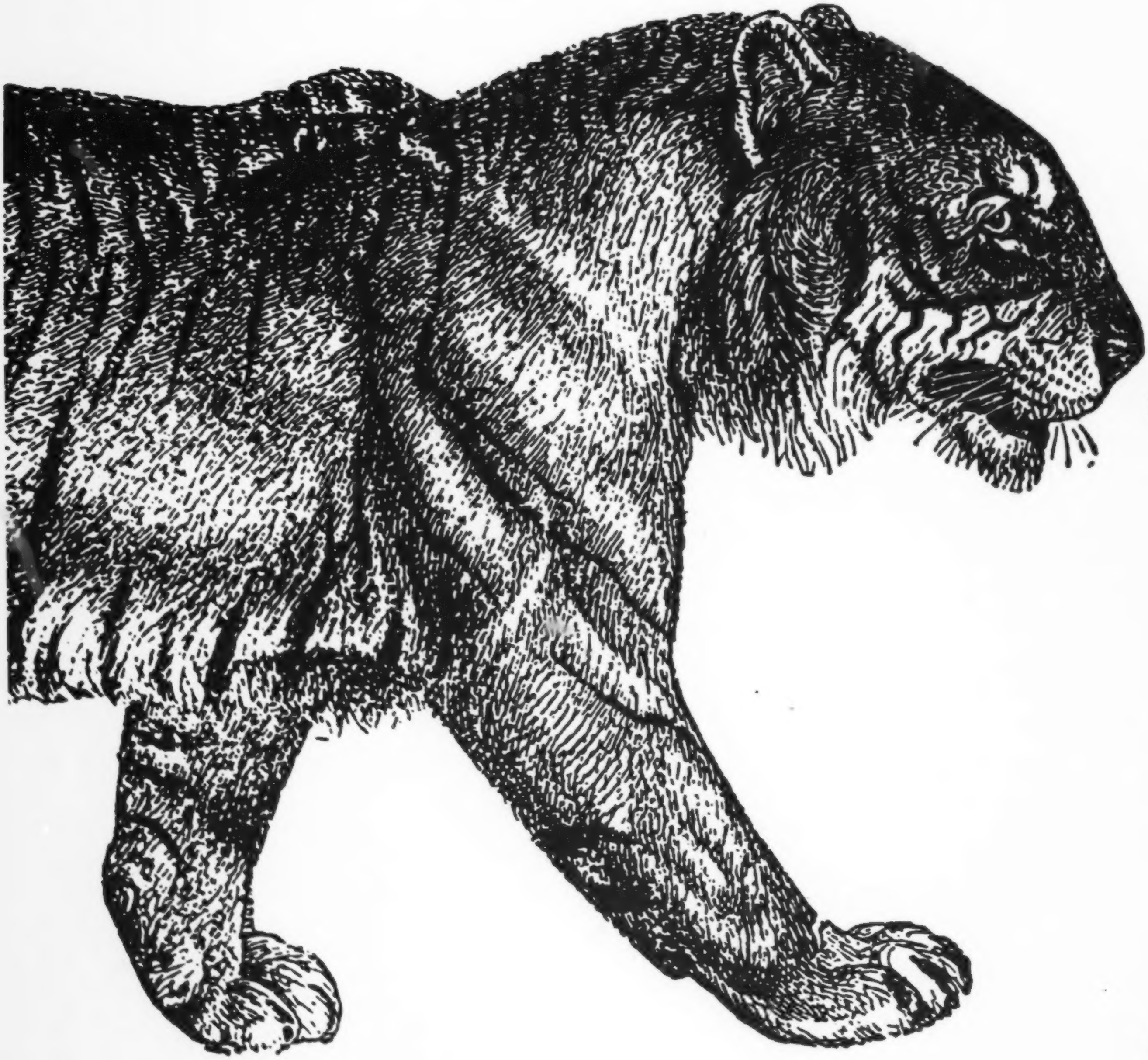
T3. *This method does not clean up oil. It only breaks it up into tiny droplets that are not as noticeable. Detergents are sometimes used in this way to speed up natural dispersal.*



4. How could the environment be damaged by use of detergents?

T4. *The detergents could harm water animals and reduce the waterproof characteristics of ducks and other water birds.*

In actual use, detergents are designed to allow natural clean-up to take place more easily. Results would not be noticeable for a longer period of time.



THE CASE FOR CASE STUDIES

10.

Environmental case studies are written accounts of events that have actually taken place or are made-up to demonstrate a process or series of events that students can analyze to learn more about some aspect of an environmental problem. For example, by having your class read and discuss a case study outlining how a group of students took action to solve a local environmental issue, your students can discuss the process they used, what worked and what didn't, alternative strategies, and so on. Using case studies can help your students evaluate real life situations and help them decide how they would and should act in similar situations. By developing your own case studies, you can emphasize the skills, knowledge, and attitudes that make the most sense for your situation. You can also tailor the scenarios to fit the cultural norms of your community.

We've included two examples of case studies here. The first examines the devastating famine that struck the Sahel in the 70s. The second includes several case studies that focus on sustainable development.

ACTIVITIES IN THIS SECTION

1. **THE SAHEL FAMINE: ARE WE CREATING DESERTS?** adapted from *Living Lightly on the Planet—Volume II.* Used with permission through arrangement with the Schlitz Audubon Center of the National Audubon Society, 1111 East Brown Deer Road, Milwaukee, WI 53217. (Copyright material. All rights reserved.)
2. **SUSTAINABLE DEVELOPMENT**, adapted from *Teacher's Guide to World Resources*, 1992-93. Reprinted with permission from the World Resources Institute, 1709 New York Ave., NW, Washington, D.C. 20006 (1992).

ARE WE CREATING DESERTS?

THE SAHEL FAMINE

OBJECTIVES:
Diagram the interrelated sequence of events that led to the Sahel famine. Describe how the concept of carrying capacity relates to the problem of desertification. Explain how specific land practices resulted in decreased fertility of the land. List and explain how alternative actions would help to reverse the global trend of desertification.

AGES:
Intermediate, advanced

SUBJECTS:
Science, social studies

MATERIALS:
Copies of pages 249-252, large sheets of paper, world map, and two tin cans with tops and bottoms removed

What happens when human population growth exceeds the carrying capacity of an environment? What, if any, are limiting factors to continued human population growth? These questions are addressed in this case study of the Sahel famine. The disastrous drought that struck the Sahel region of Africa from 1968 to 1973 and the famine that followed focused worldwide attention on the problem of desertification. Desertification—a destruction of the biological potential or carrying capacity of the land—can ultimately lead to the formation of desert-like conditions as soil fertility declines.

The story of the Sahel famine illustrates how the interaction of social and environmental factors can lead to desertification. The fragile semi-desert environment of the Sahel region is being taxed to its limits by the rapidly expanding human population. Media images of starving children in Ethiopia have brought home the harsh realities of people barely coexisting with a parched land. Human population growth continues to exceed food production, and soil fertility continues to decline.

On a global level, over 20 percent of the Earth's land surface and 80 million people are under direct threat of desertification. Countries of the world are working together to study the problem and devise strategies for restoring the productivity of desertified lands.

1. Before distributing the case study, review any vocabulary words that may be new to your students. Point out the Sahel region on a world map. Note: These countries are outlined on the map of Africa on page 251.
2. When students have had the opportunity to read the Sahel case study, divide the class into discussion groups. Give each group a large sheet of paper and ask them to work out a diagram depicting the sequence of events leading to the famine. (This diagram is depicted on page 252.)
3. Ask each group to present their diagram to the class and discuss how social and biological events are interrelated as the cause of desertification in the Sahel region. Some additional discussion might focus on the following questions:
    - What are some of the limiting factors of the Sahel region for supporting life? (water, soil fertility, forest cover)
    - How did the well-meaning intervention of France contribute to the problems of overgrazing and overcultivation? (colonization of nomads and introduction of cash crops)

(Adapted from *Living Lightly on the Planet—Volume II*, published by the Schlitz Audubon Center.)

- Has the carrying capacity of the land been exceeded? Explain. (The pressures of increased human population and increased cattle on the land have reduced the ability of the land to support life.)

Pass out copies of page 252 and review the interrelated chain of events leading to desertification.

4. Ask students to generate some strategies for solving the problems of desertification. The key to combatting the problem is proper land use. Following are some general recommendations for controlling the problems:

- Develop grazing practices that allow the vegetation to recuperate.
- Limit overgrazing and trampling around watering areas. If a rest period is needed for vegetation, any well in the area should be closed.
- Limit the number of cattle on the range.
- Plant trees and shrubs in reforestation efforts.
- Regulate cutting of forests for fuelwood.
- Restore fallow periods for cultivated lands.
- Initiate population control measures.

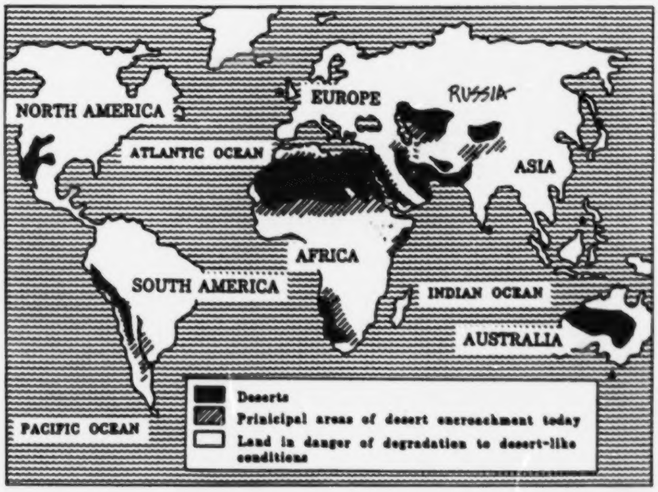
Limiting the number of cattle on the range is a key to solving the problem. However, this solution involves breaking a long-standing tradition in the Sahel where cattle are viewed as insurance against hard times. The need for education is recognized as an important part of the solution. Unfortunately, nomads of the Sahel are understandably suspicious of outside intervention. Some progress is being made, however.

In southern Niger, CARE workers are planting trees as windbreaks and increasing numbers of farmers are planting trees as a crop. Research is also being conducted to increase agricultural yields under semi-arid conditions.

5. Are We Creating Deserts?

Refer to the map here and help students identify global areas threatened by desertification. One third of the Earth's surface is arid or semi-arid. We have currently desertified an area approximately the size of China. The Global 2000 Report indicates that present global losses to desertification are estimated at approximately six million hectares a year, or an area roughly the size of Maine.

Source: Intercom #83, *Shaping the Environment David C. King and Cathryn J. Long Center for Global Perspectives.*



(Adapted from *Living Lightly on the Planet—Volume II*, published by the Schlitz Audubon Center.)

The nation that destroys its soil destroys itself.

—Franklin D. Roosevelt

EXTENSIONS

Conduct a compaction demonstration to help students understand how compaction of the soil reduces its permeability or capacity to absorb water. Cut the top and bottom out of two equal-size cans. Fill a half-gallon container with water. Then go out onto the school grounds and place one can a half inch down in the soil of a well traveled path or athletic field devoid of vegetation. Place the other can in the same type of soil in an area that has not been trampled. Pour an equal amount of water in each can and measure the amount of time it takes for the water to be completely absorbed. Ask students to account for the different absorption rates and relate this to problems of overgrazing. Bring out the fact that rain falling on compacted soils will run off and cause soil erosion. Plant roots are unable to penetrate the compacted soils and hold them in place.

Have students investigate the problem of desertification in the United States. Compared to the scale of human suffering and environmental destruction in the Sahel, our land use problems from overgrazing, deforestation and soil erosion may look minor; but destruction of rangelands and loss of topsoil present problems worthy of serious consideration. Some Bureau of Land Management employees have referred to rangelands under their jurisdiction as "10-80 lands." This refers to the fact that the range has so long been overgrazed that "a cow needs a mouth 10 feet wide and has to run 80 miles an hour just to get enough to eat." According to the United States Department of Agriculture, over half of the 414 million acres of rangeland in the continental United States are in "poor" or "very poor" condition. They report that only 15 percent of the rangeland remains in good condition.

In 1978 the Public Rangelands Improvement Act was passed that authorized a maintenance, management, and improvement program. Have students compose a class letter to the Bureau of Land Management to find out more about this act and how it is being carried out today.

Bureau of Land Management
U.S. Department of the Interior
Washington, DC 20240

(Adapted from *Living Lightly on the Planet—Volume II*, published by the Schlitz Audubon Center.)

Student Information

FAMINE IN THE SAHEL: A CASE STUDY

The year is 1973; the place, the Sahelian zone of Africa that stretches across the continent south of the Sahara desert. The countries of Mauritania, Mali, Upper Volta, Niger, Chad, and Senegal are experiencing the sixth year of a severe drought. Three hundred thousand people have died of starvation. Rivers have dried up; boats lay caked in the mud of former harbors. Grasses have withered and died. Five million cattle have perished. Their emaciated bodies surround the desert boreholes in clusters of thousands.

What has led to this disastrous famine? Is the lack of rainfall the only cause of this massive starvation, or are other factors involved? What can be done to prevent such a disaster from recurring? To find the answers to these questions, one must delve into the human history of the area, as well as the physical features of the environment. The clues to the puzzle can be found in the following passages:

The arid land of this region is mostly semi-desert. Rains come only four months of the year. The people of the Sahel had developed a remarkably efficient means of adapting to this environment. In the early 19th century, farmers grew millet and sorghum as main food staples. They were careful to let the fragile land rest or lay fallow for periods of up to 20 years between crops.

Nomadic people tending herds of cattle also lived in close harmony with the semi-desert environment. They developed a seasonal migration pattern worked out by tribal chiefs many years ago. Part of this pattern included a cooperative arrangement with the farmers. During the dry season, nomads would take their herds to the southern part of the Sahel just above the region of the harmful tsetse fly. Here the cattle would graze the stubble of the farmers' millet fields and manure them at the same time. The farmers would give the nomads millet in exchange for the manure.

When the rains began, the nomads would herd their cattle northward to graze on the sprouting grasses. The nomads moved north as long as the grasses ahead looked greener. This migration pattern would continue until the northern limit of the Sahelian rain belt was reached. The nomads would then slowly return to the south, allowing their cattle to graze on new grasses that sprouted behind them on their northern trek. The standing water remaining after the rain provided drinking water. The cattle would then return to graze the farmers' fields of stubble in the dry season, and the cycle would continue.

In the late 19th century, these nomadic patterns were disrupted. The French, who colonized the area, misunderstood the efficiency of the nomads' existence. Their colonization resulted in the division of the Sahel into separate states. Nomads were then faced with the limitations on their freedom of movement. National governments tried to settle

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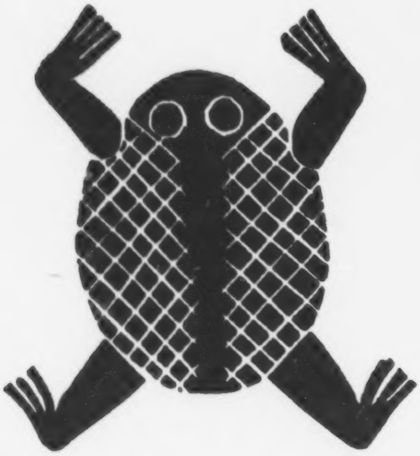
them and their cattle within their boundaries and collect taxes from them.



Changes in the traditional way of living in the Sahel were also brought about by a rapidly increasing population. In 1930, approximately 16 million people and 12 million cattle were supported by the land. Forty years later, the population had increased to 24 million people, and the amount of cattle had doubled. Increases in the number of cattle were made possible by the introduction of veterinary medicine and the drilling of thousands of boreholes, or deep wells. Water was always the limiting factor on the number of cattle in the nomads' herds. This situation changed when boreholes a thousand feet deep were drilled into the land. But, the trampling of the soil around these watering holes proved to be destructive. When thousands of cattle came to drink, they trampled plants and compacted the soil around the boreholes. As more and more cattle were added to the herds, overgrazing began to take its toll.

As a result of overgrazing, the perennial grasses of the region began to disappear. These grasses could grow up to six feet tall and had roots just as deep. As the grazing increased, the roots of the plants became more shallow and were unable to penetrate to water during the dry season. When these grasses died, coarse annual grasses grew in their place. These small plants dried up quickly and were unable to hold the soil together. Much of the fertility of the exposed land was blown away in the wind, and the land was unable to support plant life.

The growth of the human population also led more and more people to farm the fragile land. The French introduced cotton and peanuts as cash crops. This increase in cultivation placed a strain on the land. The fallow period was decreased from 20 years to five years or, in some cases, disregarded. So farmers turned to marginal lands less suited for agriculture to grow their staple food crops. The land could not support the strain of intensive agriculture. The fertility of the soil declined. As crops failed, the soil was left exposed to the forces of wind and rain. The soil eroded, gulleys were formed, and in many cases the land became barren.

The human population continued to grow by 2.5 percent each year. The scant number of trees in the region began to disappear as the number of people grew. Trees that recycle nutrients from the soil and help prevent soil erosion were cut to clear the land for farming and to provide fuelwood. The intensive cutting of trees also led to deterioration of the land's fertility.

In 1960 the Sahelian countries were granted independence. Their newly found independence was greeted by seven years of unusually heavy rains. The rains allowed more cattle to be born, and overgrazing was intensified. Attempts to induce nomads to reduce their herds were unsuccessful. Nomads have traditionally viewed their herds as insurance against hard times. In their view, cattle are like money in the

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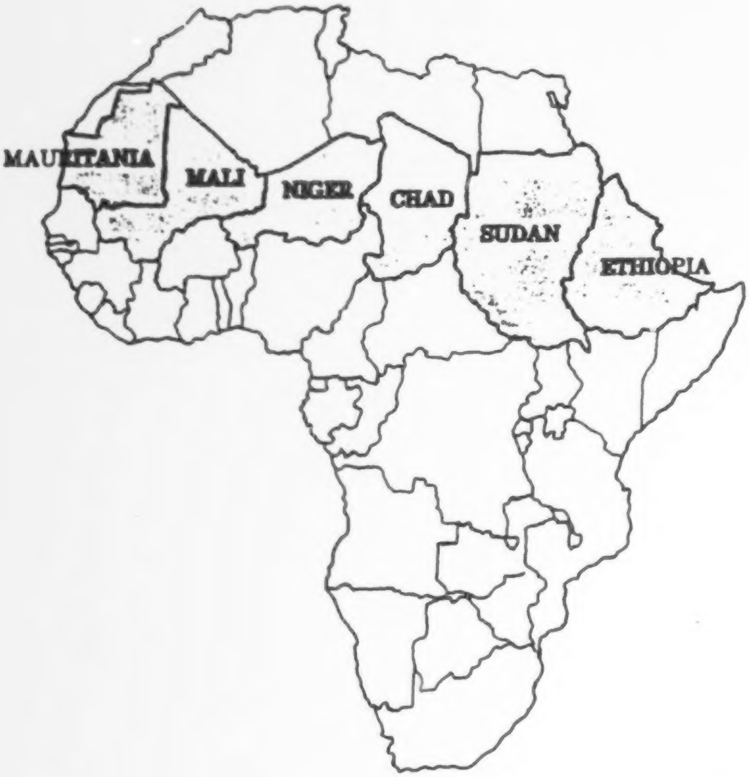
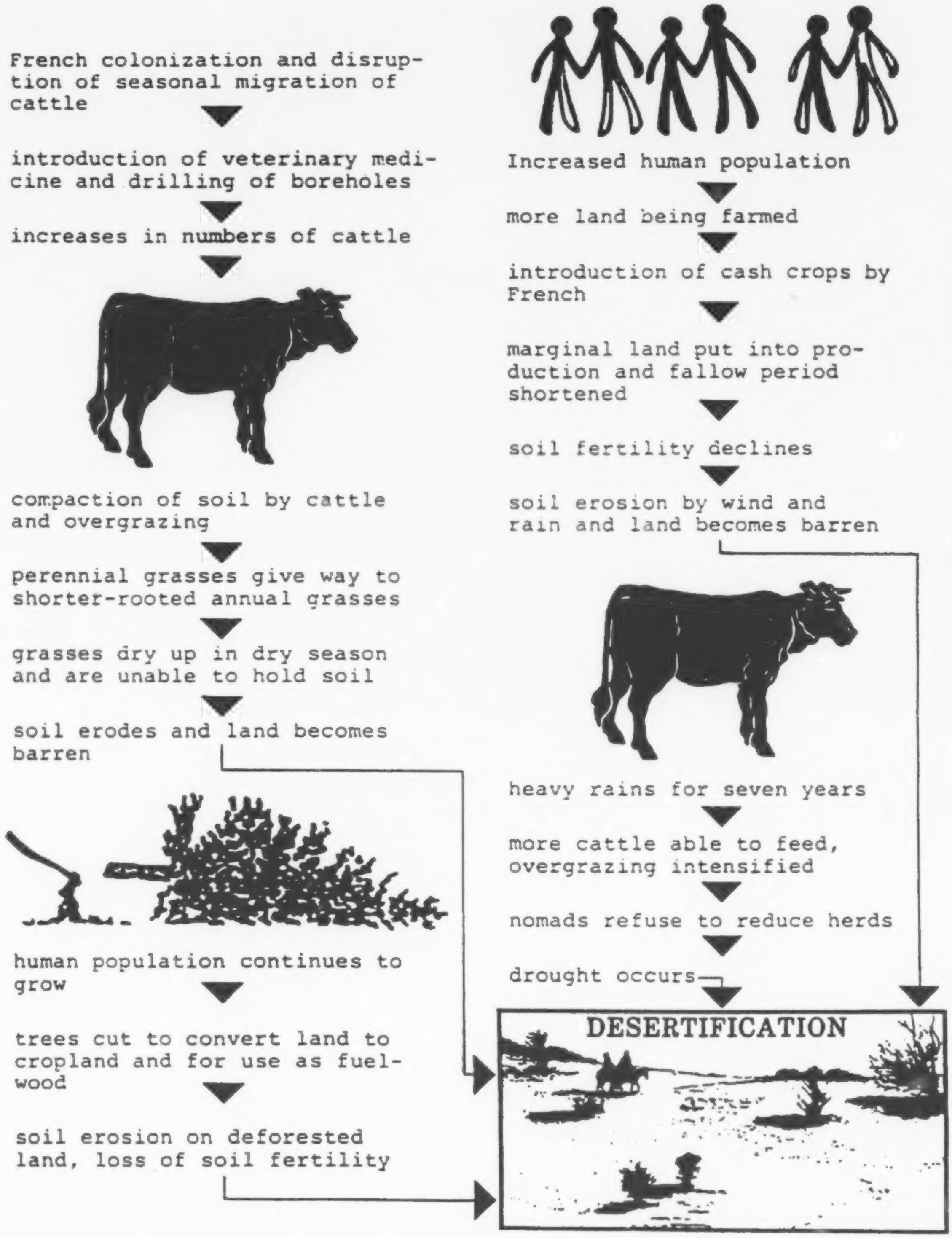
bank. They increase and multiply like money earning interest. And, unlike bags of coin that need to be transported from place to place, the cattle move themselves. Under nomadic conditions, cattle were a most appropriate form of money. As a means of cementing friendships, nomads loaned cattle or "mafista" to one another. From their point of view, it made sense to keep as many cattle on the hoof as possible.

The stage was then set for disaster. In 1968 the drought hit. The result was massive starvation and suffering. The world was stunned by the disaster. Foreign aid poured into the Sahel in an attempt to save lives. Countries of the world began to focus on an environmental problem of severe consequences: desertification.



(Adapted from *Living Lightly on the Planet—Volume II*, published by the Schlitz Audubon Center.)

DESERTIFICATION



French colonization and disruption of seasonal migration of cattle

introduction of veterinary medicine and drilling of boreholes

increases in numbers of cattle

compaction of soil by cattle and overgrazing

perennial grasses give way to shorter-rooted annual grasses

grasses dry up in dry season and are unable to hold soil

soil erodes and land becomes barren

human population continues to grow

trees cut to convert land to cropland and for use as fuelwood

soil erosion on deforested land, loss of soil fertility

Increased human population

more land being farmed

introduction of cash crops by French

marginal land put into production and fallow period shortened

soil fertility declines

soil erosion by wind and rain and land becomes barren

heavy rains for seven years

more cattle able to feed, overgrazing intensified

nomads refuse to reduce herds

drought occurs

DESERTIFICATION

(Adapted from *Living Lightly on the Planet—Volume II*, published by the Schlitz Audubon Center.)

SUSTAINABLE DEVELOPMENT

OBJECTIVES:
Define sustainable development. Identify and describe the four dimensions of sustainable development, and defend each as an important dimension of sustainable development.

GRADES:
Intermediate, advanced

SUBJECTS:
Science

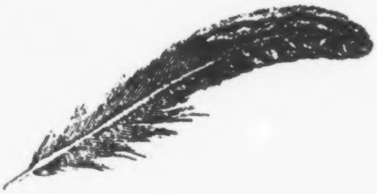
MATERIALS:
Copies of pages 256-260

What a country might do to start down the path to sustainable development depends on the country's current level of development. Needs, resources, and priorities vary from one country to another. To get an idea of this variety and of some of the possibilities, have students analyze three case studies.

Divide students into three groups. Give one group copies of page 258, "Case Study: the United States"; another group copies of page 259, "Case Study: Thailand"; and the third group copies of page 260, "Case Study: Tanzania." Give each group copies of pages 256 and 257, "Defining Sustainable Development."

STEP 1: DEFINING CURRENT STATUS

Have students work in their groups to analyze the *current status* of their country in terms of the four dimensions of sustainable development: economic, human, environmental, and technological. Case studies contain information in both the narratives and graphs that students will find helpful. Students can use additional information and data from *World Resources 1992-93* as well as other reference materials from the classroom or library. Have each group record their information.



Then, have each group report back to the class. Discuss the differences among the levels of development, environmental problems, use of energy, etc., in the three case studies so that students begin to see the distinctions between the industrialized, rapidly industrializing, and developing countries.

STEP 2: DEFINING SUSTAINABLE DEVELOPMENT GOALS

Next, have students meet in their groups again to choose some *sustainable development goals* that are appropriate for their case study country based on the current status of the economic, human, environmental, and technological dimensions. "Defining Sustainable Development" on pages 256 and 257 is a useful reference. Have the students consider which goals they should begin with, and what their countries will need to get started. (Money, obviously, but what other elements would be needed?) Record the goals and other comments.

After students have chosen some goals, have each group report its goals and discuss them. Do any of the groups have similar goals? Students will probably choose sustainable goals along the lines of the general goals outlined below. However, these are only suggestions, and class discussion need not be oriented around these goals.

ECONOMIC DIMENSIONS

- All countries need to concentrate on controlling pollution and reducing waste.
- Industrialized countries need to reduce wasteful levels of consumption of energy and other natural resources through improvements in energy efficiency and changes in lifestyle.
- Rapidly Industrializing Countries (RICs) have an opportunity to get clean technologies in place as they develop their industrial sectors.
- Developing countries, which depend on agriculture for most of their GNP, must be especially careful to conserve their soil and water resources so that their fields will remain productive.

HUMAN DIMENSIONS

- All countries need to work on meeting basic needs in health, education, clean environment, and equal participation of women and minorities.
- Industrial countries have a high literacy rate, but some have uneven distribution of health care. Their populations are mostly stable.
- RICs have achieved high literacy, improved health care, and, while still growing, their populations are leveling off.
- Developing countries, on average, are behind the other groups in health care, literacy, and equality. They must concentrate on their human resources if they are to develop the healthy, literate work force necessary for economic development. Rapid population growth has put increasing stress on services and resources.

ENVIRONMENTAL DIMENSIONS

- All countries need to improve environmental protection.
- Industrialized countries need to be more concerned with air pollution and efficient use of resources.
- Developing countries need to be concerned with basic conservation of renewable resources such as soil, water, and forests, upon which their economies are based.

TECHNOLOGICAL DIMENSIONS

- Industrialized countries need to convert to more efficient technologies.
- RICs have an opportunity to develop with more efficient technologies.
- Developing countries are mostly still agriculturally based economics. They need to develop small-scale appropriate technologies to increase agricultural productivity as well as appropriate manufacturing technologies.

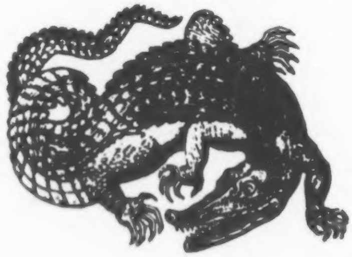
STEP 3: DEFINING RECOMMENDATIONS

Finally, have students return to their groups to recommend ideas, activities, programs, policies, etc., for reaching their sustainable development goals. Suggest that their recommendations can be (1) those that could be instituted at the national level and 2) those that would need to be instituted at the international level. Have groups record these recommendations.

When the class reconvenes for discussion, compare recommendations among the groups. What are the greatest differences among the groups? Are there any similarities? To what extent can a country "solve" its own problems? How would the recommended policies of one country affect other countries? Find out if there are conflicting national recommendations. How would they resolve these issues? How would they get international recommendations accepted?

Some international issues confronting the United Nations Conference on Environment and Development include:

- **BIODIVERSITY:** Some poor countries that are rich in biodiversity want to share in the profits of pharmaceutical companies that use their genetic diversity to develop medicines and cosmetics. Some of the big companies don't want to pay for something they get now for free.
- **ENERGY/CLIMATE CHANGE:** As poor countries grow in population and GNP, they will use more energy, and contribute more carbon dioxide to the atmosphere. Should rich countries contribute money and technology to help poor countries become more energy efficient as one way of minimizing global warming?
- **TROPICAL FORESTS:** Should rich countries have the right to tell poor countries that they can't clear their forests for agriculture (as the rich countries did) because tropical forests are a "global treasure-house" of biodiversity and the "lungs of the Earth"?



DEFINING SUSTAINABLE DEVELOPMENT: PART 1

The World Commission on Environment and Development defined sustainable development as development that "meets the needs of the present without compromising the ability of future generations to meet their own needs." (*Our Common Future*, Oxford University Press, New York, 1987, pp. 4 and 8.) The concept of sustainable development is new and controversial, and the policies needed to put it into practice are still developing. No country is yet pursuing a policy of sustainable development.

The road to sustainable development is not the same for an industrialized country, a rapidly industrializing country, and a developing country. Some steps are appropriate for all countries; others are more appropriate for countries at specific stages of development.

Sustainable development can be thought of as a process requiring simultaneous progress in four dimensions: economic, human, environmental, and technological. The sustainable development goals listed below are divided among these categories. There are close linkages among these different dimensions and actions in one area can reinforce goals in another. For example, if further economic development is to be sustainable, it cannot neglect environmental constraints or be based on the destruction of natural resources; it cannot succeed without the parallel development of human resources; it will require transformation of the existing industrial base and the development and diffusion of more Earth-friendly technologies.

Economic Dimensions

- Steadily reducing wasteful levels of consumption of energy and other natural resources through improvements in efficiency and through changes in life style.
- Changing consumption patterns that needlessly threaten the biodiversity of other countries.
- Providing leadership to support sustainable development in other countries.
- Reducing import barriers or protectionist pricing policies that limit the access that poor economies have to markets for their products.
- Using financial, technical, and human resources to develop cleaner, less resource-intensive technologies.
- Giving more equal access to resources to all people.
- Reducing growing disparity of incomes and access to health care.
- Transferring money from military and state security expenditures to development needs.
- Committing resources toward continued improvement in living standards.
- Alleviating absolute poverty.
- Improving access to land, education, and social services.
- Developing an efficient manufacturing sector to employ workers and produce goods for trade and consumption.

Human Dimensions

- Stabilizing population.
- Slowing migration to the cities through rural development.

DEFINING SUSTAINABLE DEVELOPMENT: PART 2

- Adopting policy measures and technologies to minimize environmental consequences of urbanization.
- Improving standards for literacy.
- Making primary health care more accessible.
- Improving social well-being, protecting cultural diversity, and investing in human capital.
- Investing in the health and education of women.
- Encouraging participation in decisionmaking.

Environmental Dimensions

- More efficient use of arable lands and water supplies.
- Improving agricultural practices and technologies to increase yields.
- Avoiding overuse of chemical fertilizers and pesticides.
- Conserving water by ending wasteful uses and improving efficiency of water systems.
- Improving water quality and limiting surface water withdrawals.
- Conserving biodiversity by greatly slowing and, if possible, halting extinctions and habitat and ecosystem destruction.
- Preventing destabilization of climate or destruction of the ozone layer by human actions.
- Protecting natural resources neeed for food production and cooking fuels while expanding production to meet the needs of growing populations.
- Using irrigation carefully.
- Avoiding expansion of agriculture on steep hillsides or marginal lands.
- Slowing or halting destruction of tropical forests, coral reef ecosystems, coastal mangrove forests and other wetlands, and other unique habitats to conserve biological diversity.

Technological Dimensions

- Shifting to technologies that are cleaner and more efficient—that minimize consumption of energy and other natural resources and do not pollute air, water, and land.
- Reducing carbon emissions to limit the global rate of increase of greenhouse gases and eventually stabilize the atmospheric concentrations of these gases.
- Over time, greatly curtailing use of fossil fuels, and finding other sources of energy.
- Phasing out use of CFCs to prevent degradation of the Earth's protective ozone layer.
- Preserving traditional technologies that create few wastes or pollutants, that recycle wastes, and work with or support natural systems.
- Rapidly adopting improved technologies as well as improved government regulation and enforcement.

CASE STUDY: UNITED STATES: PART 3

With a gross national product (GNP) of nearly $5.3 trillion and a GNP per capita of more than $21,000, the United States ranks as the wealthiest country in the world. Service industries—such as health care, banking, entertainment, transportation—account for about 69 percent of this wealth, manufacturing for about 29 percent.

This vast wealth still has not reached a significant and growing number of Americans. The number of Americans with incomes less than half the national median income increased during the 1980s. Absolute poverty also increased: the average income of the bottom 20 percent of U.S. families declined from $10,176 in 1970 to $9,833 in 1990.

Other measures suggest that the United States has lagged behind other industrialized countries in investing in human welfare. Mortality of children under five years of age now stands at about 10; that is about half the level that prevailed two decades ago, yet it is still higher than the level prevailing in many European countries and Japan.

Agriculture provides just 2 percent of GNP but is extremely productive; the United States is the world's largest producer of grains and maintains the third largest herd of cattle. But intensive farm practices in the United States, including heavy doses of fertilizers and pesticides, have had important environmental impacts. Massive amounts of soil and fertilizers erode from American farms and into rivers; in fact, more than half the suspended sediment and nutrient pollution in freshwater is from farms.

The country has abundant mineral resources and produces 15 percent of the world's oil, 20 percent of the coal, and 25 percent of the natural gas. It is a major producer of iron, steel, copper, cadmium, and lead.

Americans also have an enormous appetite for resources. They are the world's largest consumers of energy and the largest or second largest consumers of nine metals. They are among the world's leaders in energy use per capita and rank second in the world in water use per capita.

United States

Though still heavy users of energy, the United States also has managed to use its energy much more efficiently than in the past. From 1973 to 1988, the United States built 20 million new homes, put 50 million more vehicles on its roads, and increased its GNP by 46 percent; yet energy consumption increased only 7 percent. There is still much room for improvement, however; cars, appliances, and commercial buildings in the United States use 20–33 percent more energy than in most other industrial countries. The U.S. auto fleet uses considerably more fuel than most European fleets, primarily because the average price of gasoline is extraordinarily low by industrial world standards. U.S. residents travel more than twice as far by car each year as Europeans, partly because of the larger size of the country but mostly because of inadequate public transportation systems, lower energy prices, and the urban sprawl of the past 40 years.

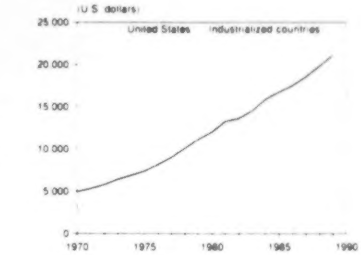
Air and water pollution have been serious problems in the United States, but clean air and clean water laws passed in the last few decades have led to improvements in some areas. Air quality is generally improving, though many urban areas do not meet national standards for smog. Sulfur emissions from utilities and other sources also contribute substantially to the acid rain that falls primarily on the northeastern United States and southeastern Canada.

The United States is the largest single emitter of greenhouse gases, primarily carbon dioxide; more than 20 percent of the carbon dioxide released from burning fossil fuels worldwide comes from the United States. The United States also has been a significant contributor of ozone-depleting chlorofluorocarbons, but has pledged to switch to substitutes by the end of 1995.

Sources:

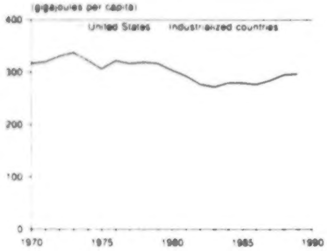
1. World Resources Institute in collaboration with the United Nations Environment Programme and the United Nations Development Programme, *World Resources 1992-93* (Oxford University Press, New York, 1992).
2. *The 1992 Information Please Environmental Almanac*, compiled by the World Resources Institute (Houghton Mifflin Co., Boston, 1991).

Figure 1 Gross National Product Per Capita



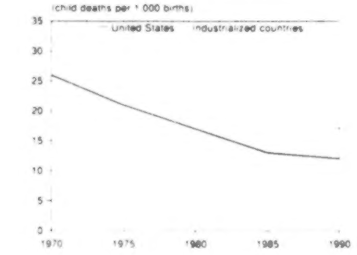
Source: The World Bank, unpublished data (The World Bank, Washington, D.C., 1991)

Figure 2 Energy Consumption Per Capita



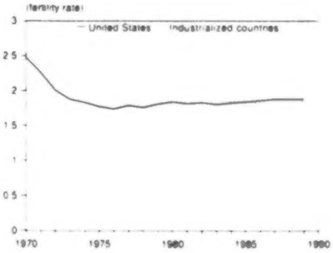
Source: The World Bank, unpublished data (The World Bank, Washington, D.C., 1991)

Figure 3 Mortality of Children Under Age 5



Source: The World Bank, unpublished data (The World Bank, Washington, D.C., 1991)

Figure 4 Total Fertility Rate



Source: The World Bank, unpublished data (The World Bank, Washington, D.C., 1991)

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CASE STUDY: THAILAND: PART 4

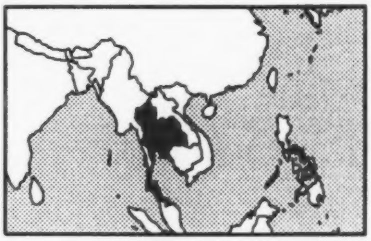
Thailand built its economic wealth on its abundant natural resources (including teak, fish, rice, and tin) but now gets an increasing share of its gross national product (GNP) from manufacturing and services. Thailand showed a sharp increase in gross national product (GNP) per capita in recent years, pulling ahead of the average developing countries.

In several cases, Thailand nearly destroyed the resource base that fueled its growth. Logging reduced Thailand forest cover from 55 percent of the country in 1961 to about 28 percent by 1988. Deforestation left large areas of bare soil, contributing to mud slides, floods, and loss of life. As a result of the disastrous floods, Thailand banned logging as of January 1989. The Thai fishing fleet, which brings in the world's third largest catch, has decimated fish populations in the Gulf of Thailand and can maintain its catch only by building larger vessels that go further offshore. The rapid expansion of brackish water prawn culture on the southeast coast has led to the widespread destruction of mangrove forests.

The natural beauty of Thailand's coastline helps make tourism Thailand's leading source of foreign exchange. Although tourism may provide an incentive to protect scenic areas, it also causes pollution in resort towns such as Pattaya.

Thailand is more ethnically homogeneous than the other Asian rapidly industrializing countries (RICs), Malaysia and Indonesia. All but 5 percent of the population is made up of Thai-speaking Buddhists. Since the 1930s, the country has mostly been ruled by a succession of military governments; in 1988, Thailand elected its first prime minister in 12 years, suggesting that democracy may be maturing.

Thailand has invested heavily in human development. Literacy now stands at 90 percent for women and 96 percent for men, comparable to that of South Korea. Deaths of children under five have dropped from 91 per 1,000 in the 1970–75 period to a projected 39 per 1,000 in 1990–95, far below the Asian average of 94. Assisted by a vigorous family planning program and rising living standards, Thailand has undergone a demographic transition to lower birth rates. The fertility rate dropped from 5.5 in 1970 to less than 3 in 1990, below the average for developing countries.



Thailand

Thailand has branched into labor-intensive industries such as integrated circuit and electronics assembly, footwear manufacturing, toy making, and textiles. Such industries have attracted considerable investment from Japan and Taiwan. Agriculture, still an important economic sector, employs the largest number of people, 18 million, or perhaps 70 percent of the work force. Northern rural areas are considerably poorer and have fewer services than metropolitan Bangkok (with 8.5 million people). On the other hand, Bangkok is choked by traffic and pollution, has no mass transit, and is home to at least 1 million squatters and slum dwellers.

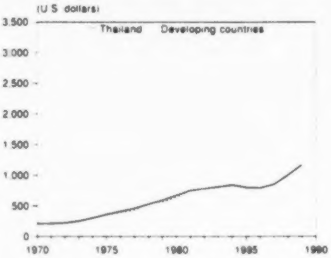
Energy use, and especially electricity use, is growing rapidly. Per capita energy consumption has increased from about 8 gigajoules in 1970 to 18 in 1990, a point slightly below the 1990 average for developing countries. Thailand has considerable reserves of natural gas, a clean-burning fuel that could be tapped for both domestic use and export in liquefied form.

Sources:

Reprinted from *World Resources 1992-93*, p. 49. Primary sources include:

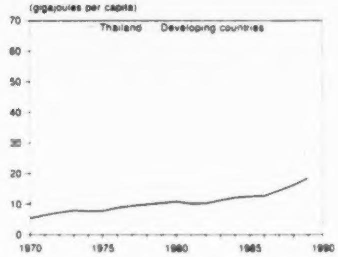
1. The Economist Intelligence Unit (EIU), *Thailand, Burma Country Profile 1990-91* (EIU, London, 1990), p. 8.
2. Theodore Panayotou and Chartchai Parasuk, *Land and Forest: Projecting Demand and Managing Encroachment* (Thailand Development Research Institute, Ambassador City, Jomtien, Chon Buri, Thailand, 1990), Appendix B, p. 74.
3. The World Bank, *Trends in Developing Economies 1991* (The World Bank, Washington, D.C., 1991), p. 521.

Figure 1 Gross National Product Per Capita



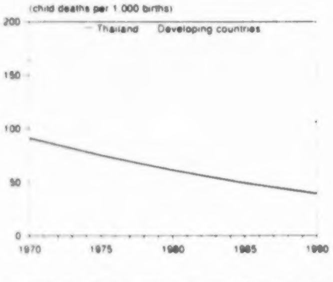
Source: The World Bank, unpublished data (The World Bank, Washington, D.C., 1991).

Figure 2 Energy Consumption Per Capita



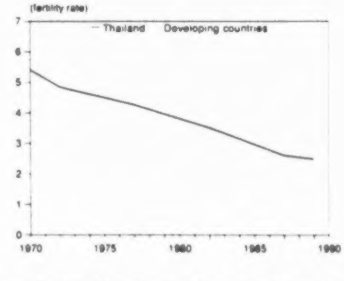
Source: The World Bank, unpublished data (The World Bank, Washington, D.C., 1991).

Figure 3 Mortality of Children Under Age 5



Source: The World Bank, unpublished data (The World Bank, Washington, D.C., 1991)

Figure 4 Total Fertility Rate



Source: The World Bank, unpublished data (The World Bank, Washington, D.C., 1991)

CASE STUDY: TANZANIA: PART 5

Tanzania, in southern Africa, with a population of about 27 million, is a poor country but one that has the natural resources to prosper. Tanzania's gross national product (GNP) per capita is a mere $120, compared to $1,170 in Thailand and $21,1000 in the United States.

Agriculture, which accounts for more than half the gross domestic product, is a top priority in the nation's development policy. About 90 percent of the work force is involved in agriculture. About 55 percent of the total land surface is potentially agricultural land, but only 5 percent is cultivated because of a lack of investments, a lack of fertilizer, and, in some areas, tsetse flies. Much of the land has a low and erratic rainfall. The leading export crop is coffee; other exports include cashew nuts, tobacco, tea, sisal, and cotton.

Tanzania, which includes the island of Zanzibar, is one of the least urbanized countries in the world. But, the country's growth rate—3.4 percent—is one of the world's highest; problems of overcrowding and inadequate housing, water supplies, sanitation, refuse collection, and transportation are common in Tanzanian cities and towns. Sixty to seventy percent of urban populations live in squatter settlements.

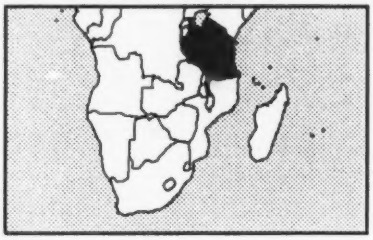
Tanzania has a widely dispersed population, but does not have an adequate transportation system of roads or railways to carry goods to market. In 1989, the World Bank launched a $750 million program to improve highways.

The government has made enormous strides in health and education programs. Thirty years ago, literacy in Tanzania was 15 percent; by the 1980s, it had reached 92 percent. Primary school enrollment was 72 percent in 1988; secondary school enrollment was 3 percent. Almost half of the population is under age 15.

The fertility rate (about 7.1) is noticeably higher than that of other developing countries (4.0). As mentioned above, the population growth rate is one of the highest in the world. Although Tanzania's infant mortality rate (158 per 1,000 births) is lower now than 30 years ago when it gained independence, it is still one of the highest in the world and considerably above other developing countries.

Tanzania's energy use per capita (14 gigajoules) is far below the United States (324 gigajoules) and even well below other developing countries. However, the country's very high population growth rate means that there will be a growing pressure on natural resources for subsistence and commercial purposes.

There is no comprehensive national environmental legislation or policy for Tanzania, and there are environmental problems in almost every part of the country. Although half of the country's land is suitable for grazing, 60 percent of this is infested with tsetse flies and thus, is not usable. Animals are concentrated in certain areas, leading to overgrazing, soil erosion, low productivity, and land degradation.



Tanzania

Trees are disappearing as more land is cleared for agricultural purposes. Urban growth has also led to deforestation around cities. And since the population depends almost entirely on wood for fuel, fuelwood gathering is causing serious deforestation.

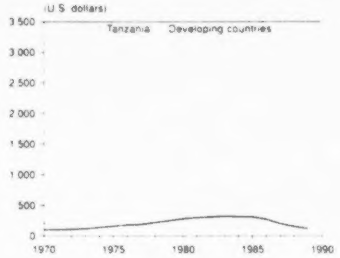
Tanzania has substantial mineral resources in gold and phosphates and may have offshore oil reserves as well. Fishing is an important industry for Tanzania. Coral reefs near the country's narrow coastline are highly desirable areas for fishing as well as for tourism, but the use of dynamite by fishermen has damaged much of them.

Tanzania's wildlife resources include 11 national parks, 18 game preserves, and 48 controlled hunting areas. Building up the country's tourist industry could be a huge boost to the economy, but without a strong environmental policy, this could have devastating long-term effects.

Sources:

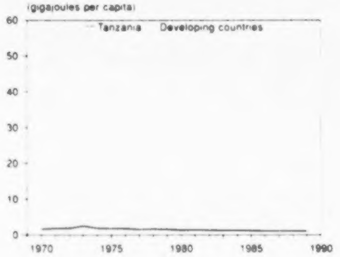
1. World Resources Institute in collaboration with the United Nations Environment Programme and the United Nations Development Programme, *World Resources 1992-93* (Oxford University Press, New York, 1992).
2. *The 1992 Information Please Environmental Almanac*, compiled by the World Resources Institute (Houghton Mifflin Co., Boston, 1991).

Figure 1 Gross National Product Per Capita



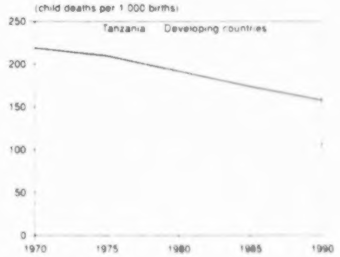
Source: The World Bank, unpublished data (The World Bank, Washington, D.C., 1991)

Figure 2 Energy Consumption Per Capita



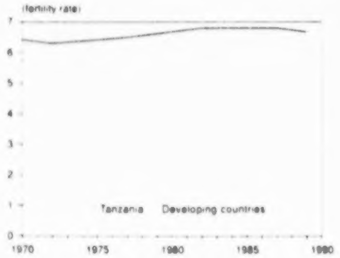
Source: The World Bank, unpublished data (The World Bank, Washington, D.C., 1991)

Figure 3 Mortality of Children Under Age 5



Source: The World Bank, unpublished data (The World Bank, Washington, D.C., 1991)

Figure 4 Total Fertility Rate



Source: The World Bank, unpublished data (The World Bank, Washington, D.C., 1991).

11.

MORAL DILEMMAS

> *What is moral is what you feel good after.*
>
> —Ernest Hemingway

How can you help students move to higher stages of moral development? One way is to have students interact with other students that are at a higher level of moral reasoning. It's the same idea behind athletes wanting to play their sport with someone that's better than they are because they have more chance of picking up something valuable from a more experienced and advanced player. Another way to encourage moral development is to model good moral behavior—something a teacher does consciously or unconsciously. For example, freedom to learn, human dignity, and justice are universally accepted values that many educators model in their day-to-day teaching.

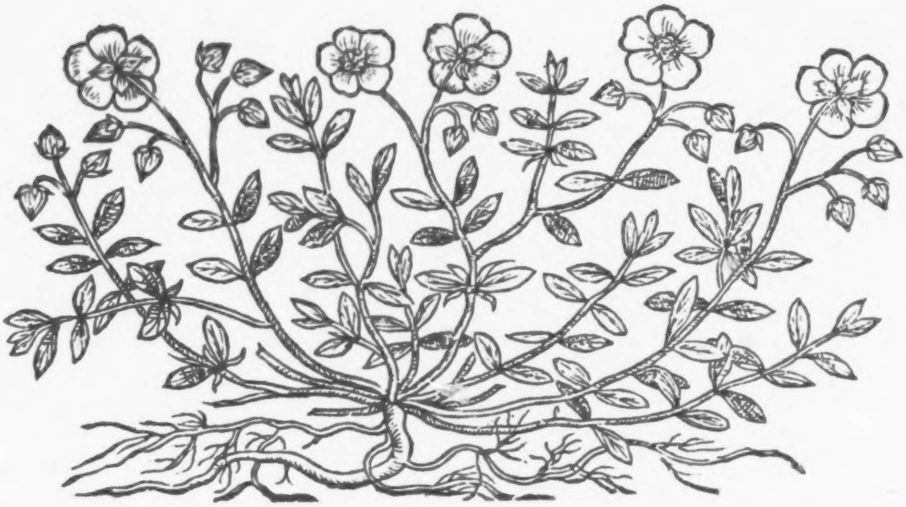
A third way to stimulate moral growth is to present students with moral conflict situations and have them struggle with moral reasoning that is just above the level they are currently operating on. This internal struggle can help them wrestle with their own values and beliefs and provide experience in using higher level moral reasoning skills.

When creating moral dilemmas for your students, try to write scenarios that are as simple as possible, using a main character or group of characters as the focus. Create the dilemma so that it's open-ended and involves an issue that has some type of moral implication for the main character(s). For example, an individual is faced with making a decision that has implications that can affect his or her own life, family, community, and environment. At the end of the scenario, ask the students to think about what the character(s) should do?

In facilitating moral dilemmas, try to stay neutral and encourage students to interact with each other, listening to other opinions and raising questions and responding to other student responses. Also encourage students to defend their points of view and discuss differing beliefs openly. In this section, we've included four examples of moral dilemmas. The first focuses on hunting endangered bats. The second is a dilemma involving the use of banned pesticides. The third looks at pesticide use in forests. And the final dilemma looks at giving food to a starving nation. Use these examples to create your own dilemmas, incorporating local and regional issues and problems.

ACTIVITIES IN THIS SECTION

1. **THE FLYING FOXES OF SAMOA** by Judy Braus and Martha Monroe.
2. **SCENARIO: HARRY CARTER'S GRAIN COMPANY**, an excerpt from *Decisions for Today and Tomorrow* by Louis A. Iozzi, Cook College, Rutgers University, New Brunswick, NJ, and Peter Bastardo, Highland Park Public Schools, Highland Park, NJ (1987, 2nd edition 1990). Published and distributed by Soplis West, Inc., Colorado.
3. **HARD CHOICES**, reprinted with permission from *Project Learning Tree* published by the American Forest Council and the Western Regional Environmental Education Council.
4. **STARVING NATION,** reprinted with permission from *Assessment of Learning Outcomes in Environmental Education* by Louis Iozzi, Danny Laveault, and Thomas Marcinkowski (published by UNESCO, 1990).



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THE FLYING FOXES OF SAMOA

OBJECTIVE:
Develop higher reasoning skills in students.

GRADES:
Intermediate

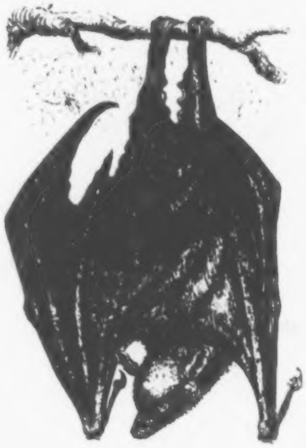
SUBJECTS:
Social studies

MATERIALS:
Copies of the story

As long as Sione could remember, his family hunted the Pe'a or flying foxes. For many years, he and his family ate the bats, along with reef fish and vegetable crops. But in the last few years, Sione and his family sold the bats to traders, who shipped them to Guam. Sione had heard that the people in Guam had over-hunted their bats until there were no longer any left. And that's why the people in Guam paid so much money for Samoan bats.

Sione and his family needed the extra money he made from selling bats, especially since the fishing in his village was not as good as it once was. The fish were smaller, and some of the tastiest fish had just seemed to disappear from the reef. Sione also knew that his family was worried about not selling as many fish at the market. And he knew that selling bats gave them the money they needed to buy food and clothing.

A few months ago, Sione's teacher told his class that so many people were killing the bats that they might become extinct. That had worried Sione, since he always wanted there to be bats for his family to hunt. Sione had also learned from his teachers that the bats were important to Samoans in other ways. They brought tourists to the island, who spent money in the country. And the bats helped to pollinate many of the fruits he and his family ate.



Sione continued to hunt bats and sell them to the trader. But one day he noticed a sign in his favorite hunting area. It said: "Hunting Bats is Illegal! If you are caught killing bats, you will be fined and the bats will be taken away." Sione knew his family was depending on him. But he didn't know if he should break the law. And he also didn't want the bats to disappear from Samoa, as they had in Guam.

QUESTIONS:

1. Should Sione continue to hunt bats?
2. Should he discuss the new law with his family?
3. What are the other ways he could generate money for the family?

HARRY CARTER'S GRAIN COMPANY

OBJECTIVE:
Read and discuss a moral dilemma about the use of banned pesticides.

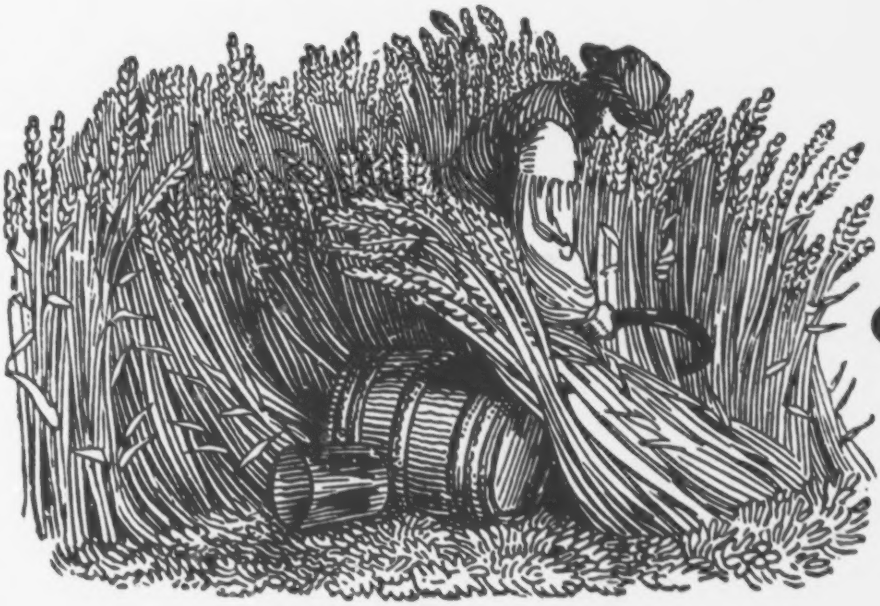
GRADES:
Intermediate, advanced

SUBJECTS:
Social studies

MATERIALS:
Copies of the Scenario

In this activity, your students will get a chance to debate a dilemma involving the use of banned pesticides. Have students read the first part of the scenario on page 265. Discuss the questions following the first part before having the students read further. Make sure the students understand the problem as well as the causes and effects.

After students read the rest of the scenario, discuss the questions that follow it, and have students vote, by show of hands, on what the jury's decision should be.



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SCENARIO: HARRY CARTER'S GRAIN COMPANY: PART 1

The Great Midwest Grain Company (GMGC) was having trouble keeping its stored grain supplies free of molds and pests. Something had to be done! Customers were canceling orders and business was going downhill very quickly. If the company closed, the town of Junction would be devastated.

Harry Carter, owner of GMGC, tried to correct the problem; nothing worked. He knew that at one time heptachloride was used in homes, in gardens, and on farms to ward off pests and prevent molds. However, in 1983 the EPA had banned the use of heptachloride. It was suspected of causing damage to the liver and kidneys of infants, as well as birth defects and cancer.

Harry knew heptachloride was effective and inexpensive. He had used it for years without observable negative effects, and he questioned the EPA's judgment in outlawing it. He felt that the EPA could not conclusively demonstrate that heptachloride caused damage. Before it was banned, Harry's company had purchased a large supply of heptachloride. He checked the warehouse and found that hundreds of bags were still there. He wondered what would happen if he mixed small amounts of heptachloride with the feed? Harry had eaten beef from cattle that had consumed grain with large amounts of heptachloride in it, and he was still okay.

Harry was faced with a declining business. If he didn't do something soon, he and all the people who worked for him would be ruined. Harry also knew that mixing the prohibited chemical with the grain was illegal. He could go to jail.

What factors should Harry consider?

What are the most important considerations? Why?

Heptachloride is only suspected of being, rather than proven to be, harmful to humans. Does this make a difference? Why or why not?

Does Harry have a responsibility to do all he can to save his company? Why or why not?

Does he have an obligation to save his employees' jobs? Why or why not?

Does it matter that what Harry is considering is illegal? Why or why not?

Does Harry have a responsibility to the people who buy his grain? If so, what is his responsibility?

What should Harry Carter do? Why?

Harry decided that he had to take a chance. But he wouldn't involve anyone else in breaking a law, even one he felt was wrong. He mixed heptachloride with the grain each night. Since no one was at work then, no one else in the company knew what was happening. He continued his personal crusade to "save the town" for nearly two years. During that time it appeared that maybe Harry was right. Nothing happened. Until . . .

Gary and Joan Carlson had been operating their small farm for two years. They weren't making much money, and they were working long hours, but they were happy. "At least we have fresh air," Gary said.

"Yes, and fresh food, and milk from our own cows," Joan added. "And our baby will be born healthy out here."

SCENARIO: HARRY CARTER'S GRAIN COMPANY: PART 2

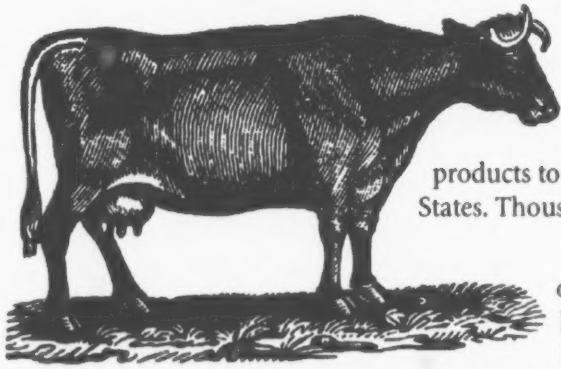
The baby was born, and the new parents were proud and happy. As time passed, however, Joan realized that the baby wasn't developing as quickly as she thought he should. She talked to her husband about it.

The Carlsons took little Davey to the doctor for an examination. Their worst fears were realized—Davey was "severely" brain-damaged. The doctor had no explanation.

"What could have gone wrong?" Joan cried. "During my pregnancy I did everything I was supposed to do. I didn't drink alcohol or smoke; I even gave up coffee. I did no hard physical work. No one in my family or yours has a history of this type of thing. Why did this happen?"

"Maybe the doctor is wrong," Gary said. "Let's wait and see."

A few weeks later, Gary came into the house. "I don't understand it," he said. "Another cow is very sick. This is the fourth one. The other three have died. What could it be?"



Heptachloride was found in the bodies of the dead cows. And the Carlsons' cows were not the only ones in the area to be affected. Shortly after the news broke, Harry Carter admitted that he had mixed heptachloride with his grain. The grain company sold its products to farmers in a dozen states in the central United States. Thousands of cows were contaminated.

When the Carlsons learned about the effects of heptachloride, they began to suspect that it had caused Davey's brain damage. Joan had been contaminated by the "fresh and wholesome" milk from her own cows. She passed on the harmful effects to her baby before he was born. "Davey didn't have a chance," she said.

On behalf of their baby, the Carlsons brought suit for damages. They argued that their baby's health was ruined because Harry Carter laced the grain with heptachloride, an illegal and harmful chemical. Harry's lawyer argued that it was not proven, nor could it be proven, that the heptachloride was responsible for the baby's brain damage.

Harry's lawyer noted, "My client admits to illegally mixing heptachloride with his grain. However, he did that to save jobs and to keep the town of Junction alive. It has never been proven that heptachloride causes any harm. The government only suspects it causes some problems. In fact, they didn't even require that the milk from these cows be removed from the grocery store shelves. They only recommended that people not drink it. My client feels sorry for the Carlsons. But he didn't cause their baby's condition."

The Carlson's lawyer argued, "How many infants need to be damaged before something is done? There is ample evidence that lab animals are harmed by heptachloride. Livers and kidneys are damaged. Cancer was caused in those animals. Must babies die first? Harry Carter is without question responsible for the baby's condition, and the jury can help serve the cause of justice by ruling in favor of my client."

Harry Carter's lawyer argued, "You can't say that because lab animals are harmed by a chemical, humans will also be harmed. Lab animals and humans are very different. Besides, in lab tests large quantities of chemicals are fed to the animals, not the very small quantities that my client used. He benefited the community for all those years. Don't abandon him now."

What factors should the jury consider?

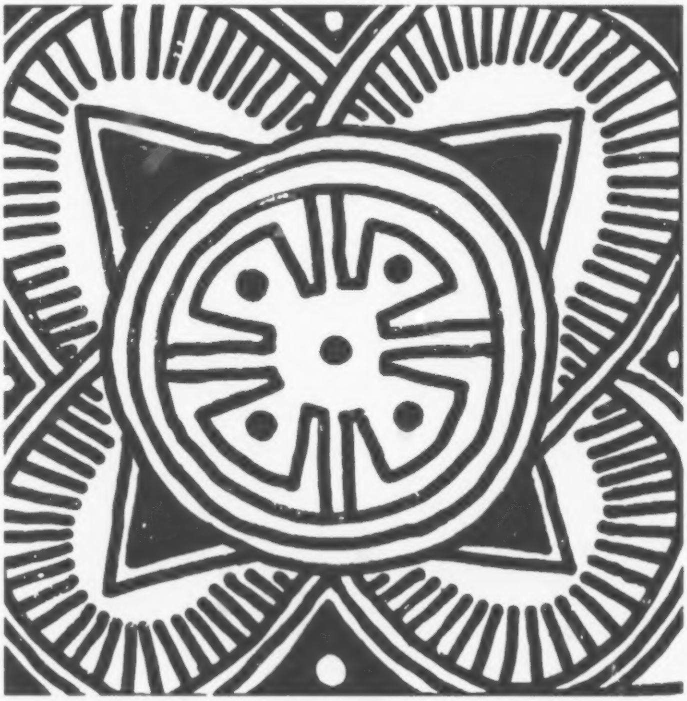
What is the most important factor? Why?

Jobs are important to the community. Shouldn't the residents of Junction be willing to risk some possible side effects? Why or why not?

What responsibilities do manufacturing companies have toward their communities?

Researchers have frequently been criticized by various industries for applying to humans the results of tests on animals. Do you think that such conclusions are valid? Why or why not?

How do you think the jury should rule—in favor of Harry or in favor of the Carlsons? Why?



HARD CHOICES

OBJECTIVES:
Describe some of the environmental and economic tradeoffs involved in the use of pesticides in the forest.

AGES:
Advanced

SUBJECTS:
Social studies, science

MATERIALS:
Information on DDT

Ask your students to read and respond to this hypothetical situation:

"Those insects have to be stopped before they destroy our entire forest," Bob Wilcox, president of the Freight Lumber Co., said. "They are killing nearly all of the trees, and if we don't spray them soon with DDT our company will be without a continuing lumber supply, and that means the mill will close."

"I agree that you've got a problem," responded Chuck Davis, owner of Oldtown's largest salmon cannery. "But you can't use DDT. A few years back they used it up in New Brunswick on spruce budworm, the same bugs we've got, and it cut their annual salmon run down to about one-sixth of what it had been. If that happens here, my company would be wiped out—and so would all the jobs on the fishing boats."

"But DDT is the only pesticide that will do a quick and thorough job on those budworms," Wilcox argued. "I don't want to destroy your operation and kill all those fish, but I've got my own company, and all those trees to consider. If I don't spray I'll be ruined."

Hold a class discussion on these questions:

How well informed do Mr. Wilcox and Mr. Davis appear to be?

What can these people do to solve their problem? What are their choices?

It is possible that Mr. Wilcox does not have the choice to use DDT, given bans on its use in recent years.

What are the reasons for bans on use of DDT and bans and restrictions on use of other pesticides?

What pesticides are currently allowed, for what reasons, and under what conditions?

What possible positive and negative effects might result from use of specific pesticides you research?

What possible positive and negative effects might result from no use, attempting no chemical treatment of the problem?

How would you resolve the dilemma outlined in this hypothetical situation? What information do you need before making your decision? On what criteria would you base your judgment? What legal constraints must be considered? What alternatives are available that have not been discussed? Which of the alternatives seem most reasonable? Given sufficient information concerning this hypothetical situation, what solution seems most appropriate?

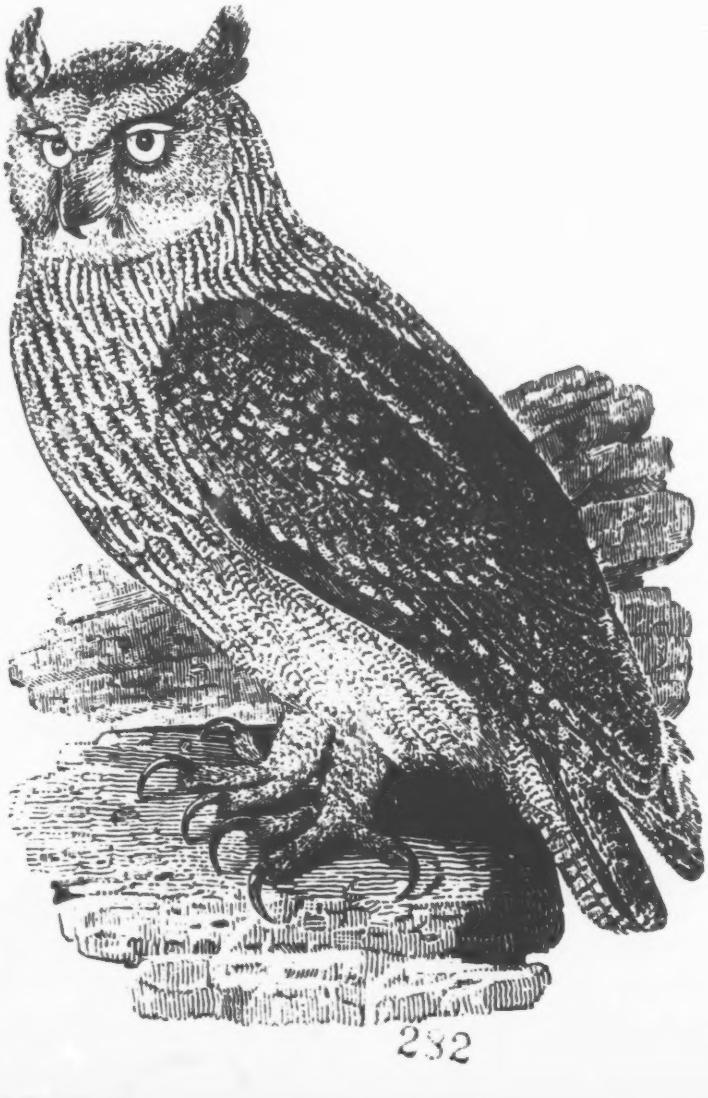
VARIATION OR EXTENSION

After students are familiar with the situation described, divide your class into three groups. Ask the first group to advocate the use of DDT; the second to oppose its use, and the third to represent the United States Environmental Protection Agency (EPA).

The first two groups should research and prepare testimony to be heard by the EPA panel. The panel will be asked to decide whether the situation warrants issuing an emergency exemption for the use of DDT, in accordance with the 1972 regulations banning the chemical.

Students preparing for the "hearing" should consider:

- The economic implications and long-range environmental impact of granting or not granting the permit.
- Alternatives or compromise solutions to the problem.
- The EPA criteria which must be met before the use exemption can be approved. (Students role-playing the EPA should research and establish these based on the most current information available.)



STARVING NATION

OBJECTIVE:
Discuss a moral dilemma involving food aid to a starving nation.

SUBJECTS:
Social studies

GRADES:
Advanced

MATERIALS:
Copies of the questionnaire on page 271

Ruvaria, a small, overpopulated, and unfriendly nation, was faced with the great problem of finding more food for its starving people. In fact, living and health conditions became so bad that many people were dying. Others were suffering so much that they wanted to die. Most of the deaths involved babies, young children, and the elderly.

A group of Americans became very concerned about Ruvaria's problems. They asked the President of the United States to help the Ruvarians and give them the needed food. However, the President realized that if he gave Ruvaria the food, it would serve to keep the population excessively high and might even cause a population boom. Then, when the food is gone, the people of Ruvaria will again be faced with the same problems.

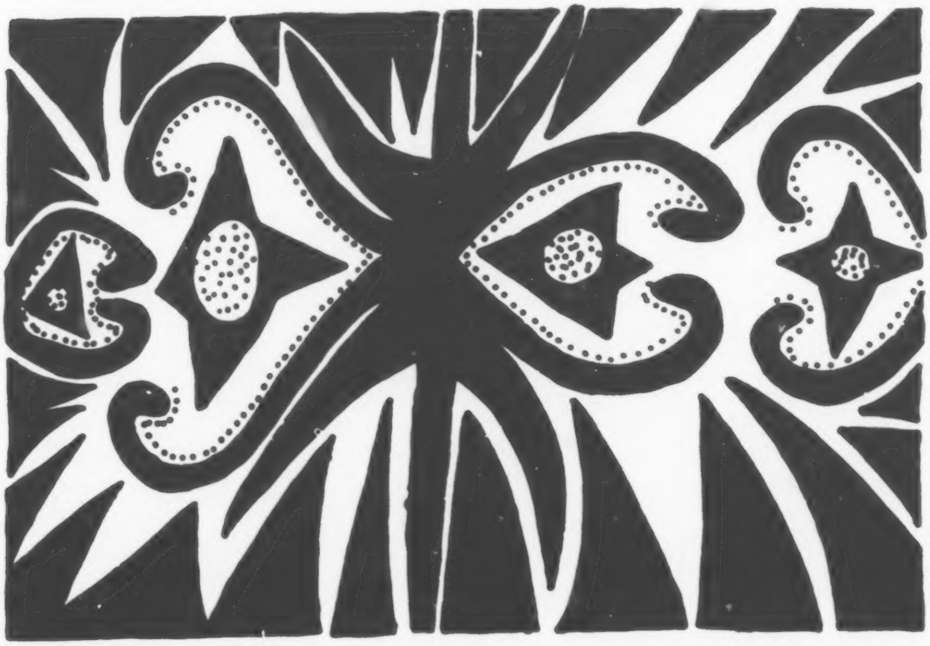
On the other hand, if the President didn't supply the food, many people would die. But, in the long run, this would greatly reduce Ruvaria's population. With a much smaller population Ruvaria would be able to support itself and allow its people to live fuller, more comfortable and healthier lives.

Should the President give the food to Ruvaria?

☐ Yes, he/she should give the food to Ruvaria

☐ Can't decide

☐ No, he/she should not give the food to Ruvaria



STARVING NATION

If you were the president, how important would each of these questions be in deciding whether or not the food should be given to Ruvaria?

GREAT IMPORTANCE	HIGH IMPORTANCE	SOME IMPORTANCE	LITTLE IMPORTANCE	NO IMPORTANCE	
G	M	S	L	N	1. Whether the starving and overpopulated country is in favor of getting the food from the United States.
G	M	S	L	N	2. Is the President of the United States obligated by international law since not giving the food to the starving nation would be the same as killing thousands of people?
G	M	S	L	N	3. Whether people would be much better off without society regimenting their lives and even their deaths.
G	M	S	L	N	4. Whether the President of the United States ignores the request and makes it appear as though he was never informed of the problem.
G	M	S	L	N	5. Does the state have the right to force some people to die and others to live against their will?
G	M	S	L	N	6. How does Russian society feel about old and very young people dying?
G	M	S	L	N	7. Whether the President has sympathy for the people suffering or cares more about what society might think.
G	M	S	L	N	8. Will raising the standard of living of the surviving Ruvarians justify the loss of human life?
G	M	S	L	N	9. Whether only God should decide when a person's life should end.
G	M	S	L	N	10. What values the President has set for himself in his own personal code of behavior.
G	M	S	L	N	11. Does International Law justify raising the standard of living for future generations at the expense of the present generation by withholding aid?
G	M	S	L	N	12. Will withholding aid in this situation set a precedent for future actions that may be motivated only by greed?

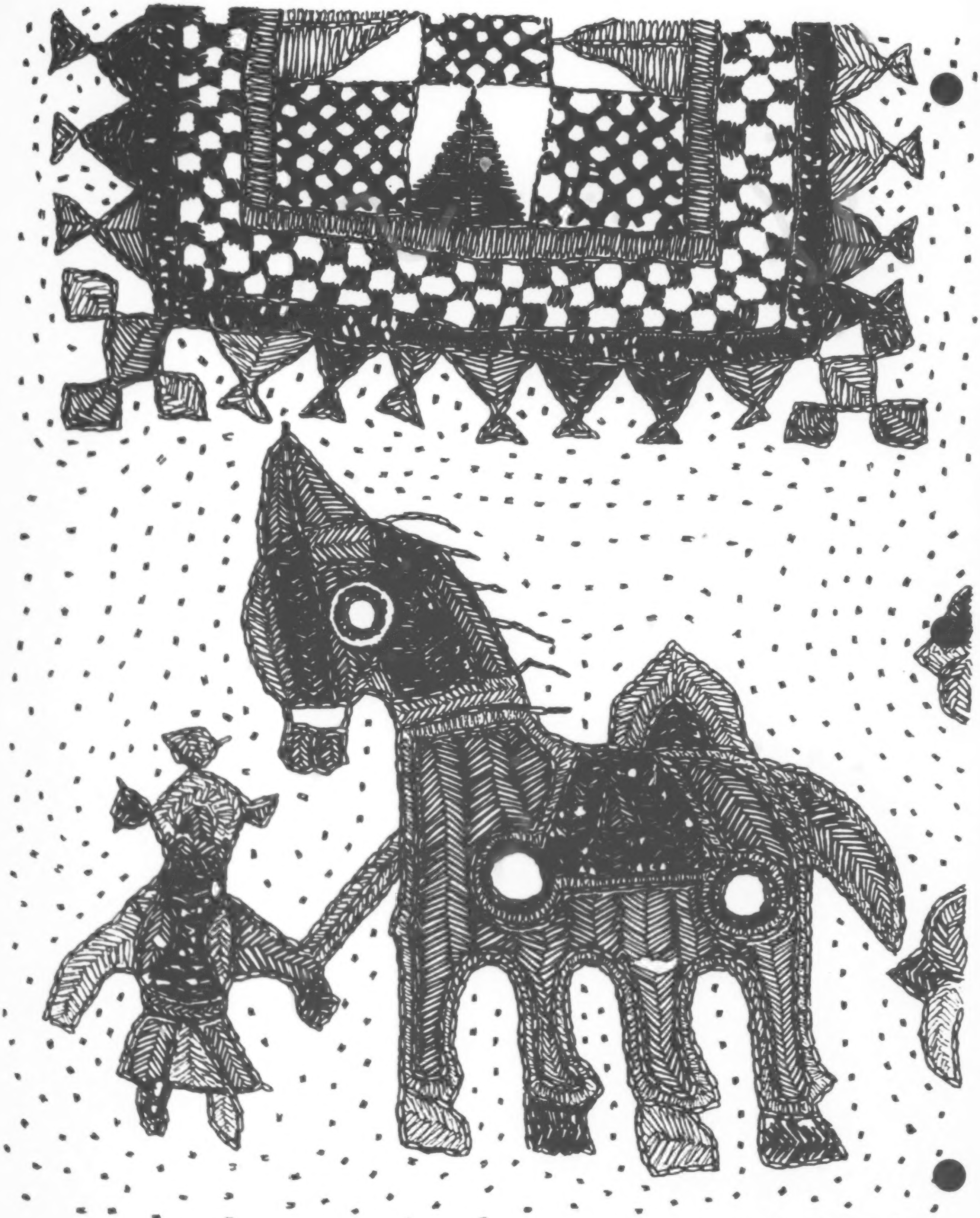
From the list of questions above, select the four most important:

____ Most Important

____ Second Most Important

____ Third Most Important

____ Fourth Most Important

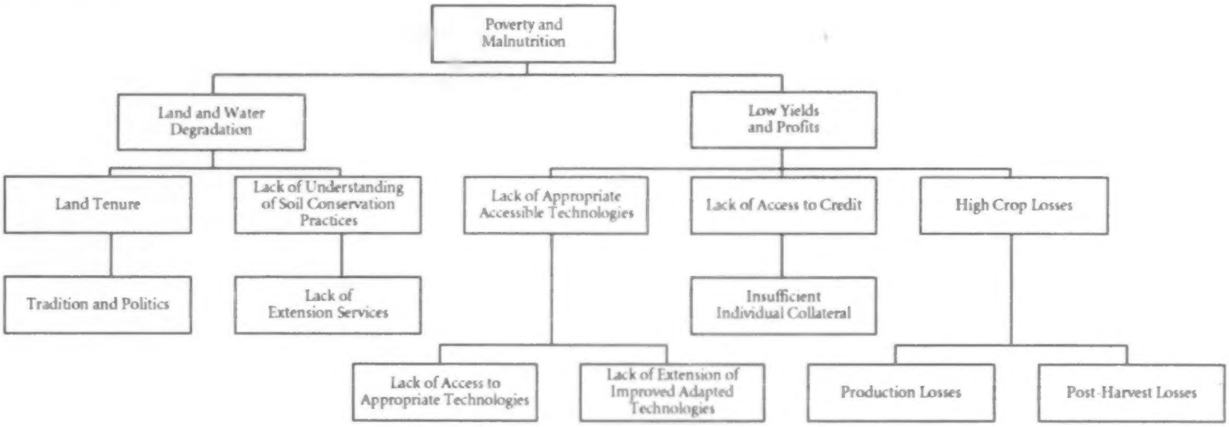


CONCEPT MAPPING AND WEBBING

12.

One way to help students explore relationships between objects, processes, events, and ideas is to use word webs or concept mapping. This technique can be used to help promote creativity, description, and understanding, and it can help improve writing skills.

Many teachers use concept mapping to create problem trees to help students develop problem-solving skills. Problem trees use the visual webbing technique to break a problem into its causes and solutions. For example, if a country has a problem with poverty and malnutrition, you could work backwards to ask why poverty and malnutrition are problems. Eventually you might build a problem tree that looks like this and includes a variety of causes and problems:


Poverty and Malnutrition
Land and Water Degradation
Low Yields and Profits
Land Tenure
Lack of Understanding of Soil Conservation Practices
Lack of Appropriate Accessible Technologies
Lack of Access to Credit
High Crop Losses
Tradition and Politics
Lack of Extension Services
Insufficient Individual Collateral
Lack of Access to Appropriate Technologies
Lack of Extension of Improved Adapted Technologies
Production Losses
Post-Harvest Losses

(Example reprinted with permission from "Peace Corps' Programming and Training System" published by Peace Corps Information and Exchange Collection, 1991.)

We've included two sample activities that make use of concept mapping. The first focuses on water and leads from webbing to poetry. The second activity makes use of concept webbing to help students understand the issues surrounding solid waste disposal and health.

ACTIVITIES IN THIS SECTION

1. **AQUA WORDS**, reprinted with permission from *Aquatic Project WILD* published by the Western Regional Environmental Education Council (1987).
2. **INFUSION ACTIVITY FOR ENVIRONMENTAL HEALTH**, adapted with permission from *An Environmental Education Approach to the Training of Elementary Teachers: A Teacher Education Programme* published by UNESCO-UNEP International Environmental Education Programme (Environmental Education Series #27).

AQUA WORDS

OBJECTIVES:
Students will be able to describe a variety of ways and reasons why water is important to people and wildlife.

AGES:
Primary, intermediate

SUBJECTS:
Language arts, science

MATERIALS:
Writing materials, pictures (optional)

Water is central to all life and life activities. Plants and animals must have water to survive. Water represents about 75% of a person's body weight and covers nearly 75% of the earth's surface. Nearly everything on earth can be directly or indirectly traced to a connection with water. Rocks channel water into streams; streams and rivers carry water across the land. Ponds, lakes, marshes, and swamps often hold water in place. Trees draw water from the soil and transport it up into leaves and out again into the air. Clouds are airborne carriers of water across the sky.

Wildlife needs water for survival. The water must be clean and free of toxic contamination. Humans use water for many purposes other than drinking. Care must be taken to protect water quality.

Water is a source of beauty and recreation. It is the basis of a massive planetary transportation system. Water grows our food, cools our cars, and is one of the first things on the list of substances the astronauts take into space. The driest desert has water—and there are about 320,000,000 cubic miles of water in the oceans. The tiny plants that live in the earth's oceans—phytoplankton—produce one-third or more of our oxygen, a gas vital to vertebrate respiration.

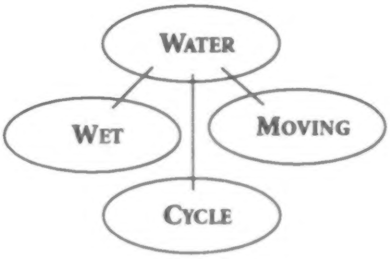
PROCEDURE

1. Have the students bring in photographs from magazines that show water. Ask them to look especially for pictures that show how living things depend upon water. Display these photographs and use them as a basis for discussion. (*optional*)

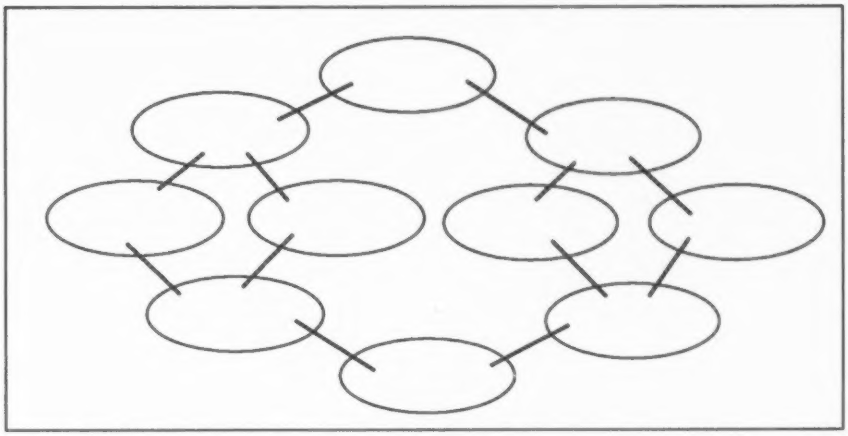
2. Ask students to think about some of the ways they have used water that day. The pictures (if collected) may be used to get them started. Emphasize how all living things are ultimately connected to water. Water is important. All life depends upon water in some way.

3. Using a long strip of butcher paper or spacious empty chalkboard for recording, ask the students to list at least 100 words that have something to do with water. Ask them to think of words about water, including its importance to people and wildlife. Keep students stretching into new areas by suggesting examples and categories of ideas if they get bogged down. *Note: For younger students, use pictures or a combination of words and pictures.*

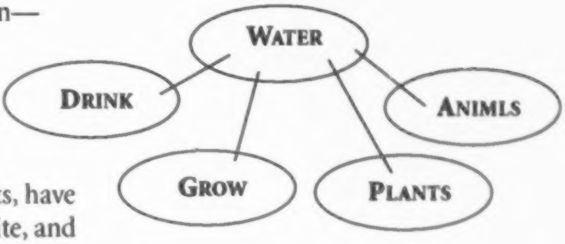
4. Using the list of words that were recorded, ask the students to create word trees of water-related words. Begin with a simple word tree like the one shown on the left.



Finally if possible, ask the students to create even more complex word trees like these:



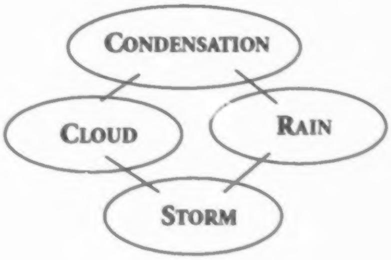
5. When students have finished several word trees, have them look at what they have done and create one or two poetic definitions of water or water-related concepts. These could begin: "Water . . . ", or "Water is . . . " For example, using the word tree condensation—*cloud—rain—storm*, you might get: "Water is gray clouds condensing into a loud summer storm." If not definitions, the students could create sentences or even paragraphs about water.



6. When students have completed their poetic statements, have them write them onto various shades of blue, aqua, gray, white, and green construction paper cut to graphically fit the feeling of their idea. Arrange these cut outs on a wall or window in an aesthetic fashion. *Note: Some students have arranged them in the shape of a stream, river, pond, lake or ocean. Others have formed the water cycle from their words and images. Some simply have written each of their words on a piece of paper shaped like a water drop.*

EXTENSION

Create a class book with each student's page included. Students write their poetic definition at the bottom of the page and then illustrate their idea—for example, with water colors—at the top of each page.



EVALUATION

Tell three ways you use water.

Tell how plants use water.

Tell how animals use water.

Why is water important?

INFUSION ACTIVITY FOR ENVIRONMENTAL HEALTH

OBJECTIVES:
Identify problem-oriented environmental and health issues associated with solid waste management issues. Identify solutions to solid waste management issues. Create an issue web showing the relationship between health and environmental issues.

AGES:
Advanced

SUBJECTS:
Health, science

MATERIALS:
Copies of page 279, chalkboard, chalk

There are several productive ways of organizing this activity. Regardless of the sequence used, teachers should engage students in brainstorming, issue investigation (i.e., using secondary sources), and synthesizing results. The following represents one way of introducing students to issue webbing.

This sequence consists of five parts. Prior to beginning the activity, teachers should be prepared to expose students to a partially completed web (e.g., the issue webbing example found in this activity, or an example of their own design) on an individual basis (e.g., individual worksheets) and on a collective basis (e.g., blackboard, newsprint, or posterboard). Teachers should begin the activity by illustrating the complexity of many environmental health issues (i.e., large issues that often subsume a number of smaller, interrelated component issues). During this introduction, teachers may need to clarify what an issue is, and to suggest that parties may be at issue over one or more problems, one or more alternative solutions, or as is often the case, some combination of problems and solutions. It may also be useful to help students differentiate between environmental and human health issues that comprise larger, complex environmental health issues.

TERMINOLOGY

Several terms are used in this activity that may require definition or clarification by the teacher. For the purpose of this activity, these terms and their intended meanings include:

ENVIRONMENTAL: primarily used in reference to natural/ecological conditions (e.g., species populations and their habitats, air and water, soil and rock layers, ecosystems)

HEALTH: primarily used in reference to human physical/ physiological conditions (e.g., skin, intestinal, respiratory conditions)

PROBLEM: primarily used in reference to perceived adverse impacts of (i.e., causes) or perceived adverse impacts from (i.e., effects) some bio-physical condition or conditions (e.g., the ecological and human respiratory effects of exposure to differing types of air pollution)

SOLUTION: primarily used in reference to alternative actions that may be taken in an attempt to curtail such adverse impacts, or to reverse the negative effects of those impacts

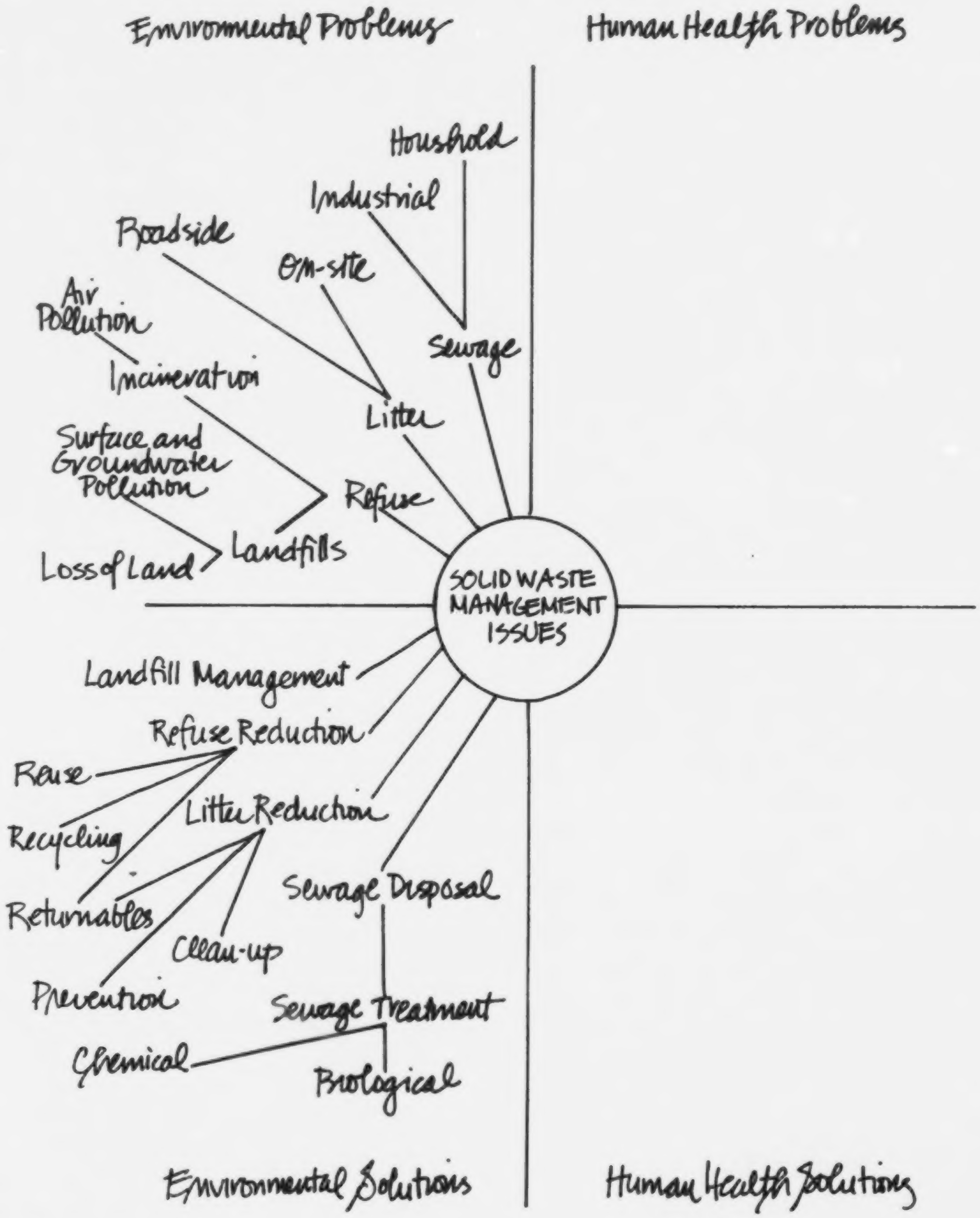
ISSUES: primarily used in reference to problems and/or solutions on which human beings (i.e., as individuals or as groups) take differing positions, and in reference to positions which they support or defend by using differing rationales

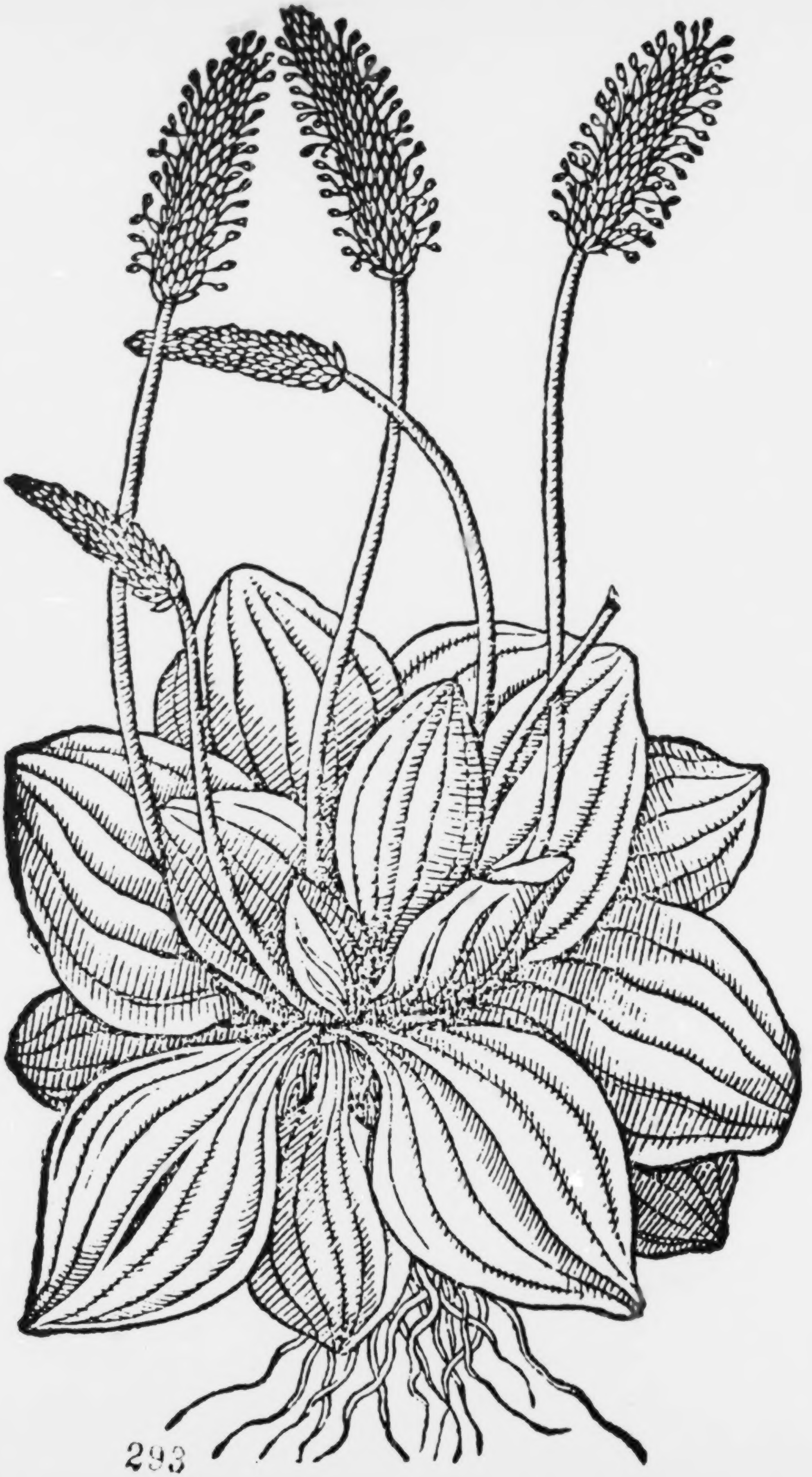
Once the teacher senses that students comprehend these aspects of environmental health issues, the teacher should introduce students to the issue they plan to use in the remainder of the activity (e.g., the solid waste management issue). The class should be presented with the large, collective representation of the partially completed web for that issue. The webbing format should be briefly described (i.e., including the four quadrants of the web). Then, the teacher should engage in two brainstorming sessions. During the first session, students are asked to suggest adding to, modifying, or deleting from the partially completed environmental side of the web. In following the rules of brainstorming, students may not modify or delete other students' suggestions (i.e., only parts of the partially completed web provided by the teacher). The teacher, or designee, should record students' suggestions in a separate list. When the list is temporarily complete, items on the list are open to discussion, and if agreed upon, to inclusion in the larger, collective web (e.g., on a blackboard). While some attention must be paid to relationships among problem- and solution-oriented issues, the emphasis should be upon developing the basic structure (i.e., component issues) of the web. This will be attended to in greater detail in the last part of the activity. Once students are relatively comfortable with the environmental side of the issue web, the teacher should oversee a second brainstorming session for the human health side of the issue web. The same rules and procedures should be followed as in the previous session.

The third part of the activity focuses upon the improvement and expansion of the issue web the class has created. Students should be organized into small groups, and assigned one quadrant of the web (e.g., solid waste-related environmental problems, solid waste-related human health solutions). It is their task to review secondary source materials that provide information about issues that fall within their quadrant. On the basis of their findings, groups are asked to add to, modify, and/or delete from the web in their quadrant. They may also be encouraged to keep notes about relevant issues that fall in other quadrants, and about relationships between issues in their and in other quadrants.

During the fourth part of the activity, each group will be asked to report back to the whole class the results of their reviews. Each group will have the chance to present and discuss their additions to, modifications of, and deletions from their quadrant of the web. Members of other groups may ask for clarification, or on the basis of their own review, provide additional insight into the proposed changes in the web. Disagreements about the inclusion/exclusion of any component issue may be resolved in several ways. If the disagreement appears to be information-based, students should be encouraged to provide information to substantiate their view. This may require additional investigation on the part of students and teacher. If the disagreement appears to be based on other beliefs or values, the issue(s) in question should be tentatively incorporated into the web (i.e., to avoid irreconcilable disagreements or rifts in the class).

At this point, the class will have pieced together a detailed graphic representation, or web of the environmental and health issues (i.e., problem- and solution-oriented) that comprise their larger issue. The final part of this activity asks students to discuss relationships among these issues (e.g., contributing causes and effects), and to depict these relationships as part of the web. They may use solid, dotted, or colored lines to depict the various types of relationships they identify. The same rules that applied to inclusion/exclusion disagreements may also be applied here. When the webbing is complete, the teacher should ask students to reflect upon the process and upon the results of their efforts.


Environmental Problems
Human Health Problems
Houshold
Industrial
Roadside
On-site
Air Pollution
Sewage
Incineration
Litter
Surface and Groundwater Pollution
Refuse
Landfills
Loss of Land
SOLID WASTE MANAGEMENT ISSUES
Landfill Management
Refuse Reduction
Reuse
Recycling
Litter Reduction
Returnables
Clean-up
Sewage Disposal
Prevention
Sewage Treatment
Chemical
Biological
Environmental Solutions
Human Health Solutions



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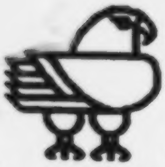


FIELD TRIPS

13.

Chase nature away, and it returns at a gallop.

—P.N. Destouches

A quiet lake. A poorly planned city. An overgrown field. An eroded stream bank. The local landfill. A recently deforested lot. Some of the most effective learning takes place outside the classroom. By taking your students on field trips, you can give them first hand experiences with natural resource and pollution issues, community resources, career opportunities, and other environmentally related topics. But before walking out the door with your students, it's important that you do your homework. Here are some field trip tips and tricks:

- Have one or more definite field trip tasks lined up. This will focus your students' attention on specific goals and maximize the value of the learning experience.
- Outline your objectives well in advance of the field trip and tie the experience to your learning objectives.
- Make sure to get permission from landowners, government officials, and others before taking students to a site.
- If possible, visit the site a week or so before you take the trip so that you know exactly what to expect. Make notes of any potential safety problems, such as slippery hills, deep water, or poisonous plants.
- Make sure to let students know what to wear and bring to the field trip, and make sure to get parental and school administration permission.

Research in the United States and other countries has shown that outdoor field trips and experiences can increase knowledge, skills, and understanding of concepts—especially with average and below-average students. Many studies also indicate that outdoor experiences can help increase a person's interest in, and appreciation of, the environment by providing first hand, concrete, and personal experiences; they can also help students develop positive attitudes toward science.

It's important to realize that outdoor experiences can take place anywhere—in urban areas looking at the built environment, in fields and forests nearby, in the local landfill or waste water treatment plant, or at a community zoo, museum, arboretum, or nature center.

We've included two sample worksheets that students could take along on a field trip to a local landfill or dump to focus their activities while they're at the site—one for primary students and one for secondary students. We've also included some generic activities that can take place at the beach.

ACTIVITIES IN THIS SECTION

1. **AT THE DUMP AND POSTCARDS FROM THE FIELD** by Judy Braus and Martha Monroe. Reprinted from a workshop report titled "Education and the Environment—The South Pacific."
2. **THE GARBAGE DUMP FIELD TRIP WORKSHEET**, reprinted with permission from *An Environmental Education Approach to the Training of Elementary Teachers: A Teacher Education Programme* published by Unesco-UNEP International Environmental Education Programme (Environmental Education Series #27).
3. **SEASIDE ADVENTURE**, reprinted with permission from *Ranger Rick's NatureScope: Diving Into Oceans* published by the National Wildlife Federation (1988).

AT THE DUMP AND POSTCARDS FROM THE FIELD

Here's a sample worksheet that students could take along on a field trip to a local landfill or dump to focus their activities while they're at the site.

AT THE DUMP

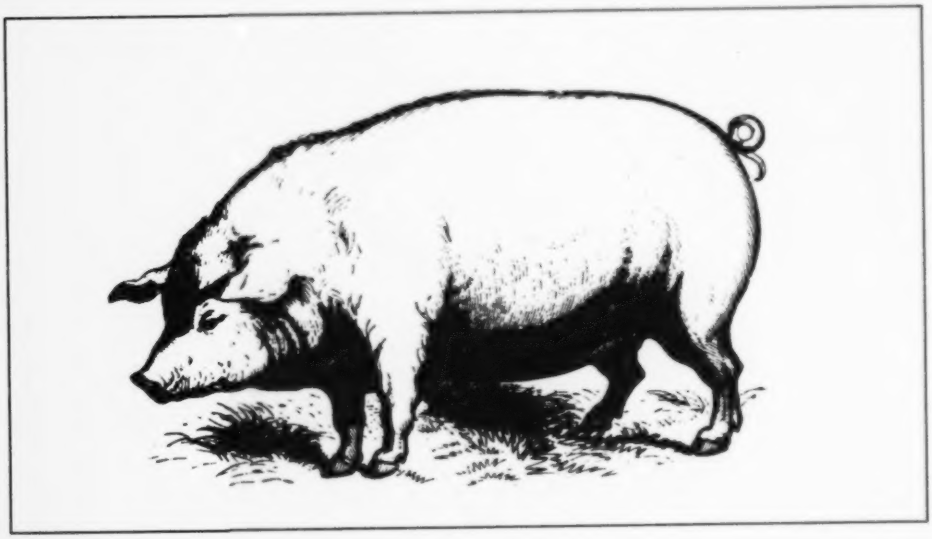
1. List the ten most common items that you see in the dump:

______________________	______________________
______________________	______________________
______________________	______________________
______________________	______________________
______________________	______________________

2. Put a check beside the items that you threw away last month.
3. Circle the items that could have been reused or recycled.
4. How does the dump affect:
    a. the amount of land in the community? ______________________
    b. the people who live nearby? ______________________
    c. nearby streams or rivers? ______________________
5. As the number of people in ______________ increases, what are your recommendations for dealing with more garbage? ______________________

POSTCARDS FROM THE FIELD

Here is a follow-up activity to a field trip that stresses art and writing. Ask students to send a postcard to a friend describing a recent field trip. Have them draw a picture in the first box showing something they saw or learned about on the field trip. Then have them write about their experiences in the second box.



Stamp

To: ____________________

THE GARBAGE DUMP FIELD TRIP WORKSHEET

Date: ______________________ Your name: ____

1. Identify, in writing, the location of the dump. What is the size of the dump site in acres or hectares?

2. How do people living in the surrounding areas use this dumping area as a waste disposal site? (Included should be a list of the major kinds of waste observed here.)

3. Dumps can be classified as sanitary land fills, rubbish burning dumps, or open dumps. Into which category does this dump fit? Why?

4. Is this a legal dumping area, i.e., does it conform to the legal statutes governing waste disposal?

5. Is there any evidence that animals inhabit the dump? If so, what kinds of animals? Do they appear to present health and/or safety problems?

6. Briefly describe the uses of the land areas immediately adjacent to the dump property. Are they residential, farm land, other? What would property values be adjacent to the dump? What kinds of problems does the dump present to area land owners?

WORKSHEET

7. Are there any waterways within or near the dump site? Do they receive runoff water from the dump? If so, what problems might this cause for surrounding communities?

8. Is there evidence of pollution in the dump area? (Consider air, noise, and visual pollution.)

9. How long can the surrounding area rely on the present disposal site? What are the future plans for waste disposal in this area?

10. Are there alternatives to dumping for the people who are using this dump? If so, what are they?

11. Can this disposal site be reclaimed? If so, how should this be done? Are there legal restrictions/ regulations governing reclamation of garbage dumps?

12. What could your class do to attempt to remedy potential/actual problems in this situation? In the case of illegal dumping, should you/your class get involved in this type of controversy? Why?

SEASIDE ADVENTURE

There are over 88,000 miles of coastline in the United States, from sandy beaches to rocky palisades. If you can, take a trip to the shore with your kids so they can explore the special habitat where land meets sea.

Below are some guidelines you can use with the kids to help them get the most out of their trip. If you're working with older kids, you might want to use the guidelines to make up worksheets. You can also divide the groups into investigation teams of three or four kids. And you might want to consider visiting the area several times during the year so the kids can compare their observations from different seasons.

OBJECTIVES:
Describe a coastal habitat. Name several coastal inhabitants and describe some of their adaptations.

AGES:
Primary, intermediate

SUBJECT:
Science

MATERIALS:
(All optional) Field guides, clipboards, paper and pencils, hand lenses, enamel pan, clear containers, plastic bucket, sieves or kitchen strainers, shovels, food coloring, medicine dropper, insect repellent, sunscreen, first-aid-kit, empty milk cartons, heavy-duty plastic, strong rubber bands

A SANDY BEACH

SHORE MATERIAL

- Using a hand lens, look closely at some sand grains. Describe their size, shape and color.
- Compare sand from the upper and lower beach.

TRACKS AND TRACES

- Examine marks on the sand. Watch creatures move and investigate the tracks they leave.
- Draw any animal tracks that you find and, if you can, name the animal that made them.
- List or draw what you find in the debris that has washed up on the shore.

SAND DWELLERS

- Scoop a shovelful of damp sand onto a sieve or kitchen strainer and see if any creatures are left behind after the sand sifts through.
- Add a shovelful of wet sand to a bucket of seawater and watch what swims out.
- Draw or describe each creature you find. Can you think of some ways each one is adapted to living in sand?

STUDY A MOLE CRAB

- Mole crabs are small, oval creatures. If you find one, put it very gently into a clear container filled with seawater. Describe how the mole crab behaves.

- Draw a picture of the mole crab and describe how its body is adapted to digging in the sand.
- Next put the crab in a pan of seawater with an inch of sand in the bottom. Describe what happens.

At a Rocky Shore

Shore Material

- Examine the rocks on the shore and describe their size, color, and texture.

Stick-Tights

- Draw several animals that are attached to the rocks.
- Describe differences you see between the attached animals that are underwater and any examples of the same species that are exposed to air.

Saltwater Plants

- Draw a picture of one kind of seaweed that's attached to the rock.
- Carefully lift up some seaweed that's draped across a rock above the water line and draw any living things you find on or under it.

Explore a Tide Pool

- Find a water-filled depression or crevice in a rock and observe what's in it. (You may want to make an underwater viewer by cutting the bottom out of a milk carton and securing heavy-duty plastic over one end with a strong rubber band.)
- Look for animals in your tide pool that crawl along or are attached to the bottom and draw a picture of one. If you can find them, also draw animals that swim and float.
- If there are any mussels in your tide pool, try this experiment. In a container, mix a little food coloring with some salt water. Use a medicine dropper to place one drop of the colored water next to the opened shell of a live mussel. What happened to the colored water? Why?

At Either Habitat

- Record the following: type of coast, location, time, date, tide (low, high, or in-between), wave conditions, and weather conditions.
- List or draw the different kinds of birds you see and describe where they are and what they're doing.

- Mark off a section of the shore from the water line to the high-tide line. Then look for distinct zones in this section marked by natural "boundaries" and describe these boundaries. (See "Things to Notice" under "Trip Tips" below.) List or draw the living things you find in each zone.
- Take a close-up look at plankton.
- List any signs of human activity (besides those of your group) and describe the effect each activity has had on the environment.

TRIP TIPS

GETTING PREPARED: Before taking kids to the shore, become familiar with the area you plan to visit. (Avoid areas with sandbars, cliffs, caves, and other "kid-tempters.") Also be sure to get permission. And you may want to find out if there's a nature center that can provide information or an on-site program for your group.

When scheduling your trip, be sure to check tide tables. Low tide is the best to see marine creatures, and it's usually the safest time to be at the shore. Review with the kids what they can expect to see and do during their visit.

WHAT TO BRING: Be sure to bring along plenty of containers so the kids can get a close-up look at the creatures they find. You may also want to bring hand lenses, shovels, and other equipment, depending on the investigations you plan to carry out.

If you're working with older children, you should bring plenty of worksheets, pencils, and clipboards. (The kids can make their own clipboards by using rubber bands to secure their worksheets to pieces of cardboard.)

THINGS TO NOTICE: As soon as you get to the shore, have the groups observe the habitat quietly. Explain that they may see more animal activity if they observe the area before disturbing it.

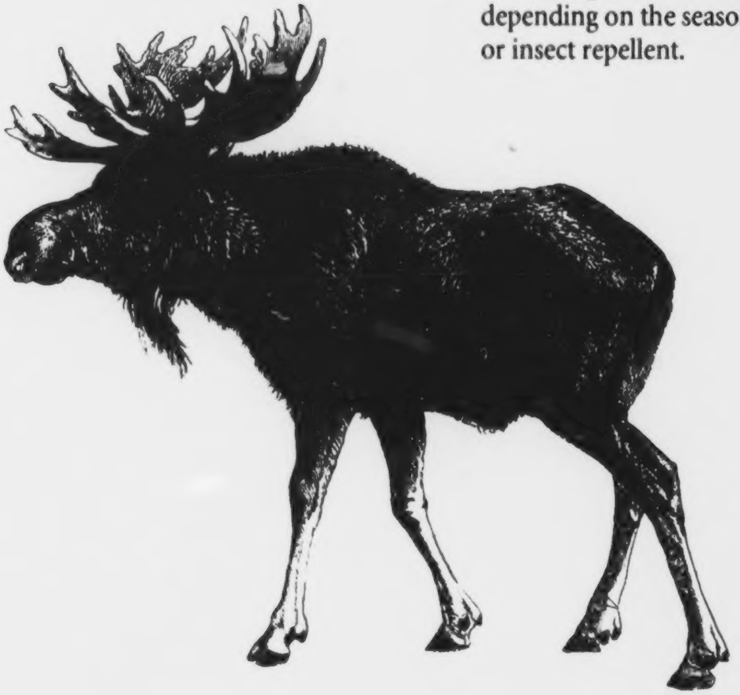
Look for distinct bands or zones between the area exposed by low tide and the area above the high-tide line. On a rocky shore these zones are especially clear. Dark, crusty algae and lichens grow above the high-tide line, and barnacles and mussels grow farther down on the rocks. Various types of seaweed grow closest to the water.

On a sandy beach the zones aren't as distinctly divided. But locating the high-tide mark is usually easy on a sandy beach. Just look for the line of debris that was left behind by the waves of the highest tide. Beyond this high-water mark, you'll often find sea grasses and other plants growing in the dry sand.

Back Where They Belong: After the kids have finished their investigations, have them replace their creatures where they found them. Also tell them to fill in any holes they've dug and to return any rocks they've overturned to their original positions.

Have a Safe Trip: By following these simple guidelines, your trip can be a safe and productive one:

- Provide plenty of adult supervision and have the kids work with partners.
- Explain that waves can be very dangerous. Have the kids try to face the waves and be aware of the waves at all times.
- Tell the kids to watch their step when walking on rocks. Remind them that even rocks that look dry can be slippery.
- Take along a first-aid kit and some drinking water. And depending on the season, you may want to provide sunscreen or insect repellent.



14.

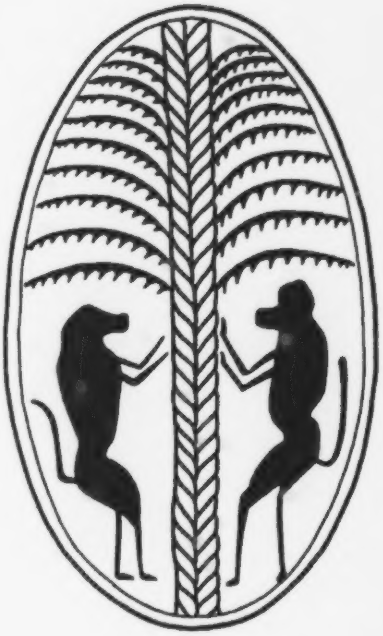
DEBATES

Most environmental issues are complicated and involve trade-offs. One way for students to understand the many sides of an issue and develop research, communication, and critical thinking skills is to take part in formal and informal debates. By picking a topic that is relevant to your students, you can encourage them to identify the pros and cons of different options and to discuss the trade-offs involved with environmental decisions. You can also give them practice in reading, writing, and public speaking.

The sample debate included here focuses on issues involved with solid waste. In the activity, there are strategies for setting up a debate, tips for debating, and research topics that you might want to adapt for your students. It's important to choose a controversial topic that doesn't have a clear right or wrong answer and is of interest to your students. Although the debate included here focuses on issues in the United States, you can use the same techniques to have your students identify and debate local and regional issues.

If you are interested in conducting a school or community forum, you might want to write to the North American Association for Environmental Education (NAAEE) to find out more about their Environmental Issues Forum (see the Bibliography for the address). The program is designed to bring citizens together in locally initiated, nonpartisan discussions about current environmental issues that concern them. NAAEE has recently published two guides: one on solid waste and the other on wetlands. You can use these guides as a model to help lead discussions about complicated environmental issues in your community.

You might also want to read about problem-posing, a technique for identifying and discussing local issues. (See *Managing a Multi-level Classroom*, Peace Corps' Information and Collection Exchange.) And see page 341 for another example of a debate called "Rare Bird Eggs for Sale."



ACTIVITY IN THIS SECTION

1. **TOUGH CHOICES**, reprinted with permission from *Ranger Rick's NatureScope: Pollution—Problems and Solutions* published by the National Wildlife Federation (1990).

TOUGH CHOICES

OBJECTIVES:
Identify the environmental pros and cons of several consumer issues. List the steps involved in making an environmentally sound decision.

AGES:
Intermediate, advanced

SUBJECTS:
Language arts, science, social studies

MATERIALS:
Easel paper or chalkboard, research materials

Making environmentally sound choices isn't easy. For example, which is better for the environment: paper bags or plastic bags? Cloth diapers or disposables? Many of the choices involve complicated issues that aren't very well understood, and the overall benefits of one choice over those of another aren't always clear. Even when all the facts are in, the decisions we make usually involve some tough trade-offs.

Have your kids research and debate several complex issues to identify the pros and cons of different options and to discuss the trade-offs involved with solid waste decisions. Then, as a group, the kids can come up with a checklist for making an environmentally sound decision.

GETTING READY

Divide the group into discussion teams and assign each team one of the questions listed under "The Issues" on page 295. Explain that each team will be staging a debate on their topic. For example, one team will focus on the issue of whether to choose paper or plastic bags at the grocery store. Some team members will support the use of plastic bags and the others will support the use of paper bags.

Tell team members to read their question and then decide which point of view they want to support. (If individuals have a tough time choosing sides, you can have the team members draw lots to make it fair.) Explain that some team members might end up supporting a position that is different from the one they currently support. Point out that no matter which side they end up on, they will learn how to develop and support arguments defending a specific point of view, and they will expand their understanding of the issues.

Explain that when the debates take place both sides will have a chance to present their case and rebut what the other team members say. Also mention that everyone on a team should take an active role in the debate.

To prepare for the debate, have team members research their topics, using current periodicals, newspaper articles, and books. Explain that they need to gather information that will help them understand the pros and cons of each alternative and gauge whether or not one alternative is better than another. They will also need to gather facts that support their arguments. (We've listed some of the pros and cons for each debate topic on page 295 to help you guide the kids' research. Also see "Current Thinking" on page 294 to find out what different experts think is the most correct action to take with each issue.)

Before starting, set a time limit for each debate and go over the "Debate Pointers" in the margin. You might also want to set up a debate format such as:

1. First group presents its case
2. Second group presents its case
3. First group rebuts and adds arguments
4. Second group rebuts and adds arguments

Explain that the observers have an important role during the debates. They should think about the following questions as they listen to each debate:

- Were the arguments convincing? Do you think the information used to support the case was reliable? Why or why not? (Try to remember specific examples.)
- Were any important issues not addressed? Do you feel that one option is better for the environment than another? Why or why not?
- Do you feel that you need additional information before you can decide which position you support? If so, what information would you need?
- Which team was most persuasive and why?

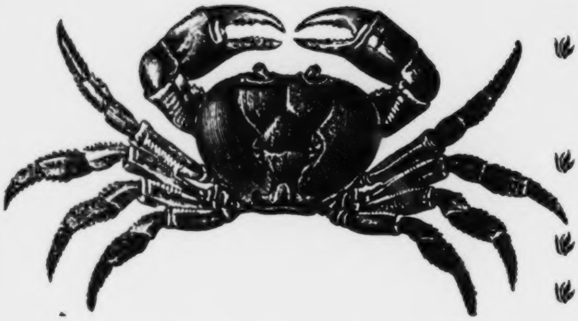
After each debate, have the observers comment on the points they were instructed to keep in mind. Then ask the debaters for their reactions to the debate. Also ask the group to think about other options that were not presented (see "Current Thinking" on page 294). For example, in the first debate, the best option for the environment—people bringing a reusable cloth bag to the grocery store—wasn't part of the discussion. Point out that articles and news programs also sometimes leave out important options. Explain that being a responsible citizen means finding out about and understanding all the choices.

Also point out that there's usually not one right or wrong answer and that environmental decisions often involve trade-offs. For example, taxing lawn care companies that use toxic chemicals could cause some businesses to go bankrupt and some people to lose their jobs. But it could also lower the threat of death and sickness from toxic chemicals.

After all the teams have presented their debates, discuss the issue of solid waste disposal in general. Mention that a combination of methods is important— there's no single right way. Also bring up the point that experts often don't agree on what the best option is, and that means individuals have to make decisions using the facts and information they have and their own value systems. As a wrap-up, have the group come up with a short checklist for making an environmentally sound choice. For example, the list might include the following:

DEBATE POINTERS

- Make sure your arguments are clearly stated, logical, and well supported by evidence.
- Explain why your arguments are important. Use examples when possible.
- Make your most important points first, and don't jump from one argument to another.
- Speak slowly and clearly so that others can follow what you're saying. Be relaxed and poised.
- Be convincing and creative.



- Find out as much information as you can about the different options from reliable sources, including experts in the field.
- Decide who would benefit and who would be harmed by each of the options. (Think about both short- and long-term consequences.)
- Learn how each option would affect the environment and other people around the world.
- Make a list of the pros and cons for each option.
- Weigh the pros and cons to make your choice.

CURRENT THINKING

It's important for students to realize that because there's so much we don't understand about environmental problems, experts don't always have all the answers. Many solid waste issues don't have clear solutions at this time, and experts feel that more information is needed before they can determine what the best solutions are. Overall, environmentalists support an integrated waste management program that emphasizes source reduction and recycling first, followed by incineration and landfilling. (Note: The pros and cons on page 295 are only a partial listing. Each issue is very complex and involves many economic and social issues.)

ISSUE 1: Environmentalists recommend that shoppers bring a reusable cloth bag to the store instead of getting new paper or plastic bags each time. Some experts say paper and plastic are equally harmful and that if you use either, you should make sure to reuse them. Others always choose paper bags over plastic.

ISSUE 2: Many environmentalists and public health professionals feel the pros of cloth outweigh the pros of disposables. Others feel that we do not know enough about the environmental effects throughout the "life cycle" of either to know which is best in the long run.

ISSUE 3: Most environmentalists aren't in favor of most types of plastic packaging, including plastic soda bottles. The current recommended action is to choose glass over plastic and to recycle the glass. Many environmentalists, however, feel that although plastic has its problems, it is here to stay, and therefore plastic recycling efforts are important.

ISSUE 4: Many environmentalists feel that we need to recycle as much as 65 percent of our garbage to handle our solid waste problems and that putting a freeze on building new incinerators and landfills would help promote the reduction, reuse, and recycling of solid waste.

Some people argue that well-managed landfills are more ecologically sound than incinerators. Others say incinerators and landfills are equally bad, though they acknowledge that both will continue to play an important role in solid waste disposal.

ISSUE 5: Environmentalists favor organic lawn care and encourage landscaping with native plants to attract wildlife and save water.

ISSUE 1: BAG IT!

QUESTION: *If given an option, should you choose a paper or plastic bag for your groceries?*

PAPER BAGS
pros: made from a renewable resource; biodegradable; recyclable; reusable
cons: most made, at least partially, with virgin fiber instead of recycled paper; timber often grown using chemical fertilizers; paper manufacturing releases toxics and other pollutants into the air and water; bulky; paper takes up more space in landfills than plastic

PLASTIC BAGS
pros: easier to carry; cheaper to manufacture; leakproof; take up less landfill space; recyclable in some places; some are made with petroleum waste products
cons: can harm wildlife; most recyclable ones are not recycled; bits of plastic can leach into water supplies as degradable plastic breaks down; most plastics are made from a nonrenewable resource; manufacturing releases toxics and pollutants into the air and water

ISSUE 2: THE BABY-BOTTOM COVERUP

QUESTION: *Should people buy cloth diapers or disposable diapers?*

CLOTH DIAPERS
pros: often cheaper; reusable; made from renewable resources; biodegradable; human waste treated in sewage treatment plants instead of going into landfills; save landfill space; can prevent rashes in some babies
cons: require energy to manufacture, wash, and deliver; energy-use creates air and water pollution; detergents can create water pollution; cotton often grown using pesticides and chemical fertilizers

DISPOSABLE DIAPERS
pros: convenient; keeps baby's skin drier
cons: human waste can carry disease, creating risk for garbage handlers; made from a nonrenewable resource; nonbiodegradable; manufacturing creates air and water pollution; take up landfill space; degradable ones can break down into tiny bits of plastic that leach into water supplies.

ISSUE 3: SODA SENSE

QUESTION: *Should you buy sodas in plastic or glass bottles?*

PLASTIC BOTTLES

pros: cheap; lightweight; recyclable in some places; inert in landfills
cons: made from a nonrenewable resource; nonbiodegradable; manufacturing creates air and water pollution; degradables can create water pollution; limited uses for recycled plastic; difficult to sort and recycle; recycled plastic is not as durable as virgin plastic

GLASS BOTTLES

pros: cheaper and easier to recycle; can be recycled many times without losing strength; made from abundant natural resources
cons: heavy; breakable; nonbiodegradable; cost more to transport; recycling uses a lot of water and can create water pollution

ISSUE 4: BURN, BABY, BURN

QUESTION: *Which is the better alternative for disposing of the solid waste we don't recycle: burning it in incinerators or dumping it in landfills?*

INCINERATORS
pros: greatly reduce the volume of trash; save landfill space; can recover energy and resources; reduce the threat of rat, roach, and other pest infestation
cons: expensive to build and operate; may discourage people from recycling (need a high volume of garbage to operate); create toxic ash that can leach into water supplies when landfilled; people don't want them nearby; require separation of trash into burnables and nonburnables

LANDFILLS
pros: easy because waste doesn't need to be separated or sorted; generate methane gas, which can be recovered for fuel; can sometimes reuse the site for other purposes
cons: hazardous materials can leach into water supplies; generate methane gas that can cause explosions if not vented; take up valuable land space; buried biodegradable materials don't biodegrade; buried resources are wasted; people don't want them nearby

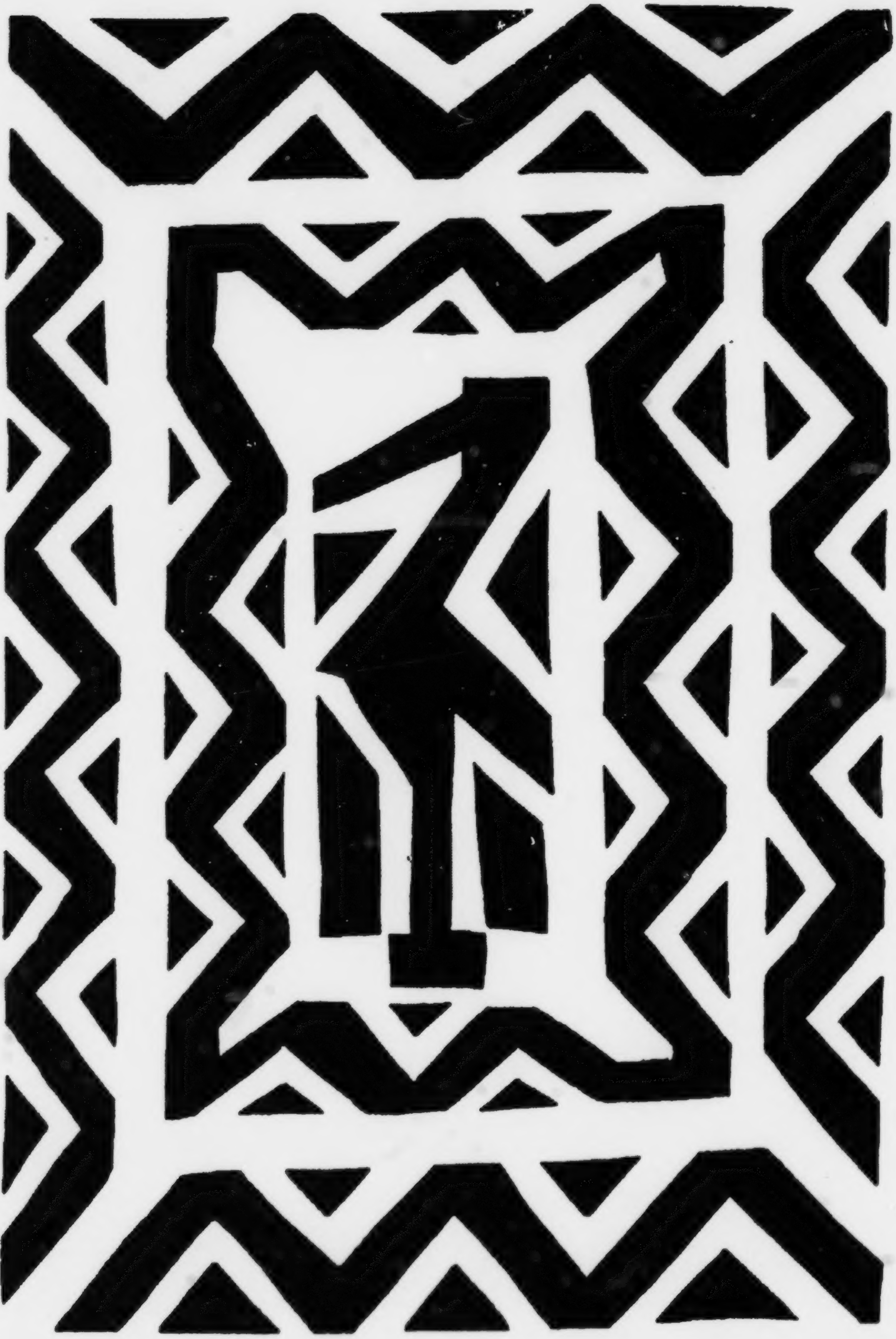
ISSUE 5: A "GROWING" DILEMMA

QUESTION: *Should homeowners use chemical lawn service companies or rely on organic lawn care? (Note: Organic lawn care uses no toxic herbicides or pesticides and no chemical fertilizers. People can either take care of their lawns themselves, using organic methods, or hire organic landscaping services.)*

CHEMICAL LAWN CARE

pros: effective in short term for controlling pests; provides "manicured" look; easy
cons: expensive; long-term effects not clear; chemicals made from nonrenewable resources; chemicals wash off in rain and pollute water supplies; chemicals can build up in soil; chemicals can poison people, pets, and wildlife; manufacturing and transporting chemicals can create air and water pollution

ORGANIC LAWN CARE
pros: nontoxic; can be less expensive; maintains ecological life-support systems; causes less pollution
cons: can take hard work if professionals not hired; short-term pest control may not be effective



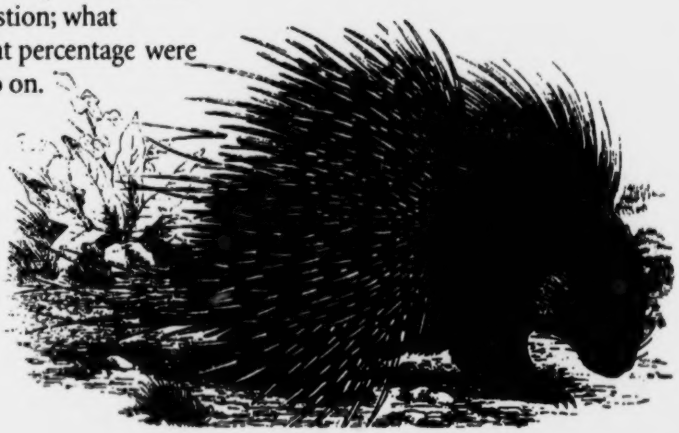
SURVEYS

15.

Surveys can help students gather and work with data about an environmental topic, find out how people think about an issue, learn how to ask questions and evaluate responses, and compare how different populations feel about an issue. Surveys can be defined as any type of instrument or activity used to gather facts or opinions about a topic. Some people define questionnaires as a special type of survey that collect facts from people about a particular subject and an opinionnaire as a type of survey used to collect opinions about topics. For example, you can develop a survey of the community to find out how many buildings are on a street, how many people live in the community, what types of plants grow in the community and so on. You could design a questionnaire to find out specific information from homeowners about a topic—for example, the number of children per family unit in a particular neighborhood or community or the types of heating systems found in the community. And finally, an opinion poll could be developed to find out how/what people think about a topic—for example, how people in the community feel about a decision to switch to new energy-efficient cooking stoves. (Note: Some people use the words *survey* and *questionnaire* interchangeably.)

We've included several examples of surveys in this manual. The first is a questionnaire designed to find out how people use and dispose of glass and metal. It is taken from materials developed by Harold Hungerford, Trudi Volk, and John Ramsey, who define a questionnaire as "a carefully written set of questions about a particular subject that is given to a carefully selected sample of human beings." The second example is an informal survey designed to help students find out how land and water use has changed in a community over time. The third activity encourages students to develop a survey to find out how much people know about food and hunger.

In addition to helping your students gather and analyze data, surveys can also promote math skills. For example, your students can figure out what percentage of people polled answered yes to each question; what percentage of males answered yes or no to each question; what percentage of the people polled were males and what percentage were females; the average age of the people polled; and so on.



ACTIVITIES
IN THIS
SECTION

1. **MODEL QUESTIONNAIRE: GLASS AND METAL WASTE QUESTIONNAIRE,** reprinted with permission from "A Prototype Environmental Education Curriculum for the Middle School," by Harold Hungerford, Trudi Volk, and John Ramsey. Published by UNESCO-UNEP International Environmental Education Program (1989).
2. **RIVERS THROUGH TIME,** reprinted from *Conserving America: Rivers* published by the National Wildlife Federation and WQED, Pittsburgh (1990).
3. **WHAT DO PEOPLE THINK?,** reprinted from *Food First Curriculum, Unit VI, A1,* published by the Institute for Food and Development Policy.

GLASS AND METAL WASTE QUESTIONNAIRE

OBJECTIVES:
Define questionnaire. Describe how a questionnaire can help analyze a local environmental issue.

AGES:
Intermediate, advanced

SUBJECTS:
Social studies, math

MATERIALS:
Model of questionnaire on page 300 and summary sheet on page 301

A questionnaire is a special kind of survey. It can be used to collect information that can only be obtained in this manner. Here's a definition:

> *Questionnaire: A carefully written set of questions about a particular subject that is given to a carefully selected sample of human beings.*

Questionnaires collect only hard, cold data, i.e., facts. They do not collect opinions people have about something. Use the examples below to explain the types of information that can be collected by a questionnaire.

1. Number of children per family unit in a particular neighborhood or community.
2. Number of gasoline-powered devices owned per family in a neighborhood or community.
3. Types of heating systems found in a particular neighborhood or community, e.g., natural gas, bottle gas, fuel oil, electric, coal, wood.
4. Garbage disposal techniques used by renters and/or home owners.
5. Number of home owners/renters recycling metal containers.
6. Average number of pets being fed by residents in a particular neighborhood or community.

The sample questionnaire on page 300 is designed to yield usable data concerning the habits people have developed relative to their use of disposal glass and and metal containers. It should be used with a member of a household, preferably the person responsible for household management. If this questionnaire is used, the size of the sample should be fairly large in order to make the data meaningful, i.e., over 50 responses. Similarly, it is suggested that data be collected and categorized (tabulated) according to particular parts of the community, i.e., high income, middle income, and low income. (See page 301.)

MODEL QUESTIONNAIRE

GLASS AND METAL WASTE QUESTIONNAIRE

Hello, my name is ______________________________. I am a student at ______________________________ school. One of my classes is doing research in environmental problems, and I would like to ask you a few questions about your use of glass and metal containers. May I ask you a few questions?

Person responding ______________________________ ☐ Male ☐ Female

____

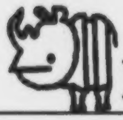
Street City State ZIP Code

1. How many people live in this household? .... ____________
2. Do you purchase any part of your groceries (other than beverages like pop, fruit juice, or beer) in metal containers? .... ____________
3. Do you purchase any of your beverages in metal containers? .... ☐ Yes ☐ No
4. Do you purchase any beverages in glass containers? .... ☐ Yes ☐ No
5. Of those beverages purchased in glass containers, what percent of the beverages are in returnable glass containers? .... ____________%
6. Regarding metal cans, what percent of them do you take to a local recycling or collection center? .... ____________%
7. Regarding throw-away glass containers, what percent of them do you take to a local recycling or collection center? .... ____________%
8. Have you (or any member of your family) ever asked your grocer to stock beverages only in reusable glass containers? .... ☐ Yes ☐ No

THANK YOU VERY MUCH FOR YOUR HELP!

GLASS AND METAL QUESTIONNAIRE
DATA SUMMARY SHEET

ITEM	POPULATION OR NEIGHBORHOOD A		POPULATION OR NEIGHBORHOOD B		POPULATION OR NEIGHBORHOOD C		TOTALS	
No. of males responding								
No. of females responding								
Average no. of people per household								
	Yes	No	Yes	No	Yes	No	Yes	No
Groceries (not beverages) purchased in metal cans								
Beverages purchased in metal containers								
Beverages purchased in glass containers								
% of glass reusable =								
% of glass throw-away =								
% of cans throw-away =								
% of cans recycled =								
% of throw-away glass thrown away =								
% of throw-away glass recycled =								
	Yes	No	Yes	No	Yes	No	Yes	No
Has any member of the family requested a grocer to stock only reusable containers?								



RIVERS THROUGH TIME

OBJECTIVE:
Design a questionnaire and interview older residents in the community to determine how land and water use has changed over time.

AGES:
Intermediate, advanced

SUBJECTS:
Language arts, social studies

MATERIALS:
Pencils, paper, tape recorder (optional)

The people who lived in Cleveland, Ohio, during the late 1960s will probably always remember June 22, 1969. That's the day their local river—the Cuyahoga—caught on fire. People in every community—especially older residents—have a story to tell about changes they've seen in local land and water use. It is often revealing to young people to learn how many changes have occurred over time and how the changes have affected water quality.

Your group can begin to piece together the events and developments that have shaped the water quality in their community by designing a questionnaire and interviewing older citizens who have lived in the area for many years.

SETTING THE STAGE

Explain the general purposes of the activity, which are to design a questionnaire about the history of a local waterway, use the questionnaire to interview several older people who have lived in the community for a long time, and come up with a "Book of Quotes" about what life used to be like in the community. Then discuss these steps in conducting a good interview:

1. Make an appointment with the person you are interviewing and let the person know in advance what the questions will be about so that he or she can prepare for the interview.
2. If you plan to use a tape recorder, make sure it works before the interview. Also make sure to bring several sharpened pencils along and enough writing paper.
3. Introduce yourself and restate the purpose of the interview, how long it will last, and how you will use the results.
4. Before using a tape recorder, ask the person's permission.
5. Be open and friendly.

Have the students conduct some practice interviews with each other to give them some interviewing experience.

PROCEDURE

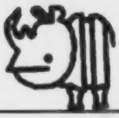
1. Have the students work in pairs to come up with a questionnaire. Here are some sample questions:
   - How long have you lived in this community?
   - Have you ever lived near the river?
   - What do you remember the river being like when you were my age?

- How have the river and the surrounding land changed since then?
- How did you and other members of the community use the river?
- What are your feelings about the river today?

2. Have each pair interview three different people in the community. Then have them conduct some additional research at the library and historical society to find out more about the history of the area.
3. Have each pair write a summary about how their river has changed over time and how the community has been affected by the changes. Then have the students put together a "Book of Quotes" about what older people in the community have said about changes in community waterways. If possible, add pictures from old newspapers to help illustrate how the river has changed over time.

SUMMARY

1. Ask the students to suggest events that might have affected the quality of the water in their community, both positively and negatively.
2. Ask how learning about the history of the community might help them plan for the future.



WHAT DO PEOPLE THINK?

OBJECTIVES:
Discover how community members view the world food system and to assess the need for education about food issues. Analyze and compare different people's perspectives. Develop communication skills by putting together survey questions, disseminating questionnaires, and interpreting the survey results.

AGES:
All

SUBJECTS:
Math, social studies, communication

MATERIALS:
Copies of a survey that the group will design—enough for three or four for each person, pencils

PROCEDURE

1. Tell the children that they are going to be responsible for creating a survey to find out other people's knowledge and attitudes about food and hunger. Explain that a survey is a study of a sample group of people's ideas and attitudes on a subject.

2. Go around the room and ask each student to contribute possible questions for the survey. Ask a volunteer to record these on the board. The questions should relate to interesting concepts learned in previous activities. Thus, the content of the survey should reflect the activities your class emphasized.

3. Have the group choose a list of eight to fifteen questions to be used in the survey.

4. Type or carefully write out the survey, leaving spaces for the answers. Make copies so that there are three or four per person in the group.

5. Distribute the surveys. Have each person fill one out. Compare the results.

6. Ask the children to take two or three surveys home and find people in their neighborhoods of any age to answer the questions. Suggest that at least one surveyed person should not be a member of the surveyor's family. Ask that they bring the surveys back to class.

7. When the surveys are returned, compile the results. Make copies for everyone of a synopsis of how the different surveys compare.

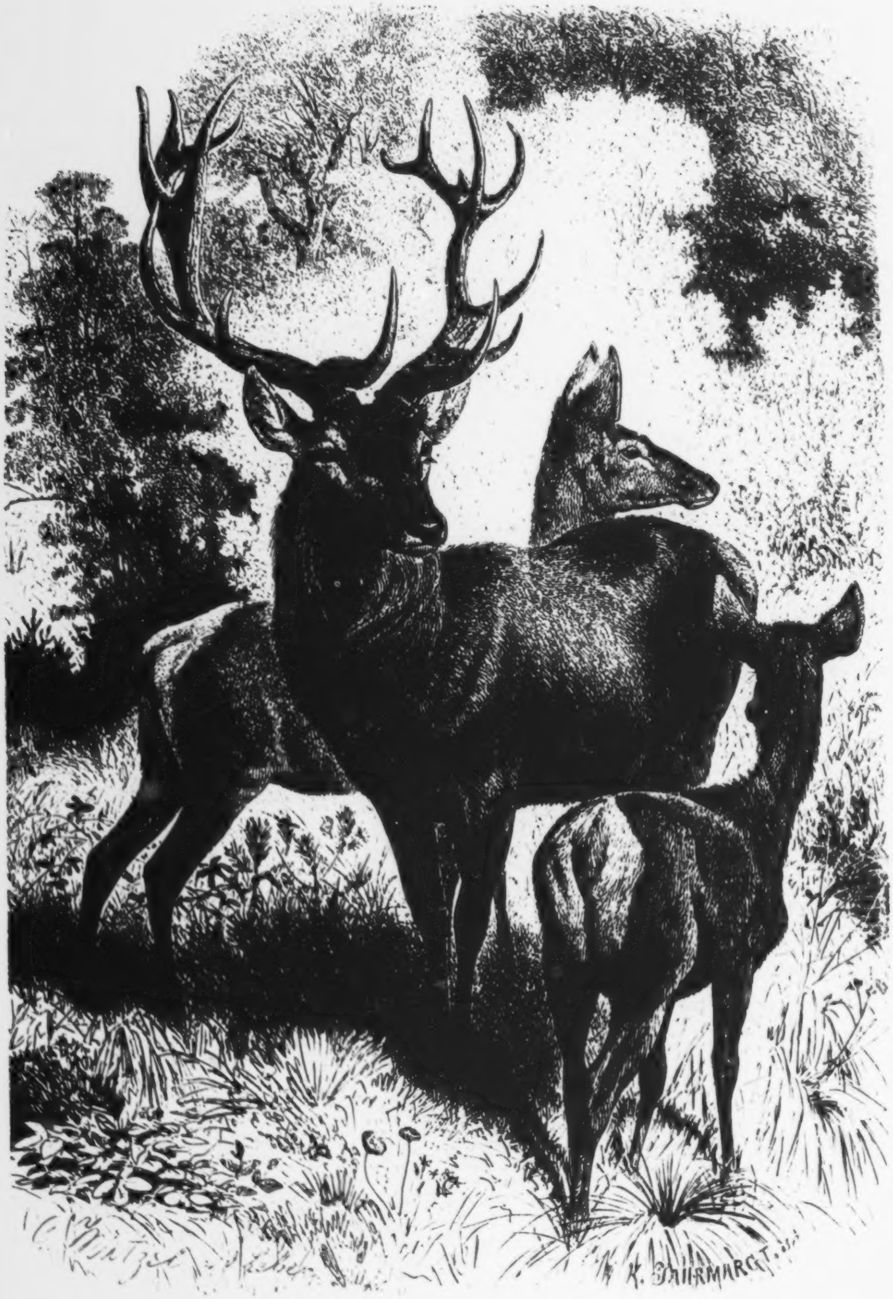
8. Distribute the survey results and return each survey to the child who was originally responsible for it. Discuss how people's attitudes differ or are the same, how attitudes of community members differ from attitudes of group members, how well-informed people seem to be, whether there are any attitudes that the children would like to change, and how these could be changed.

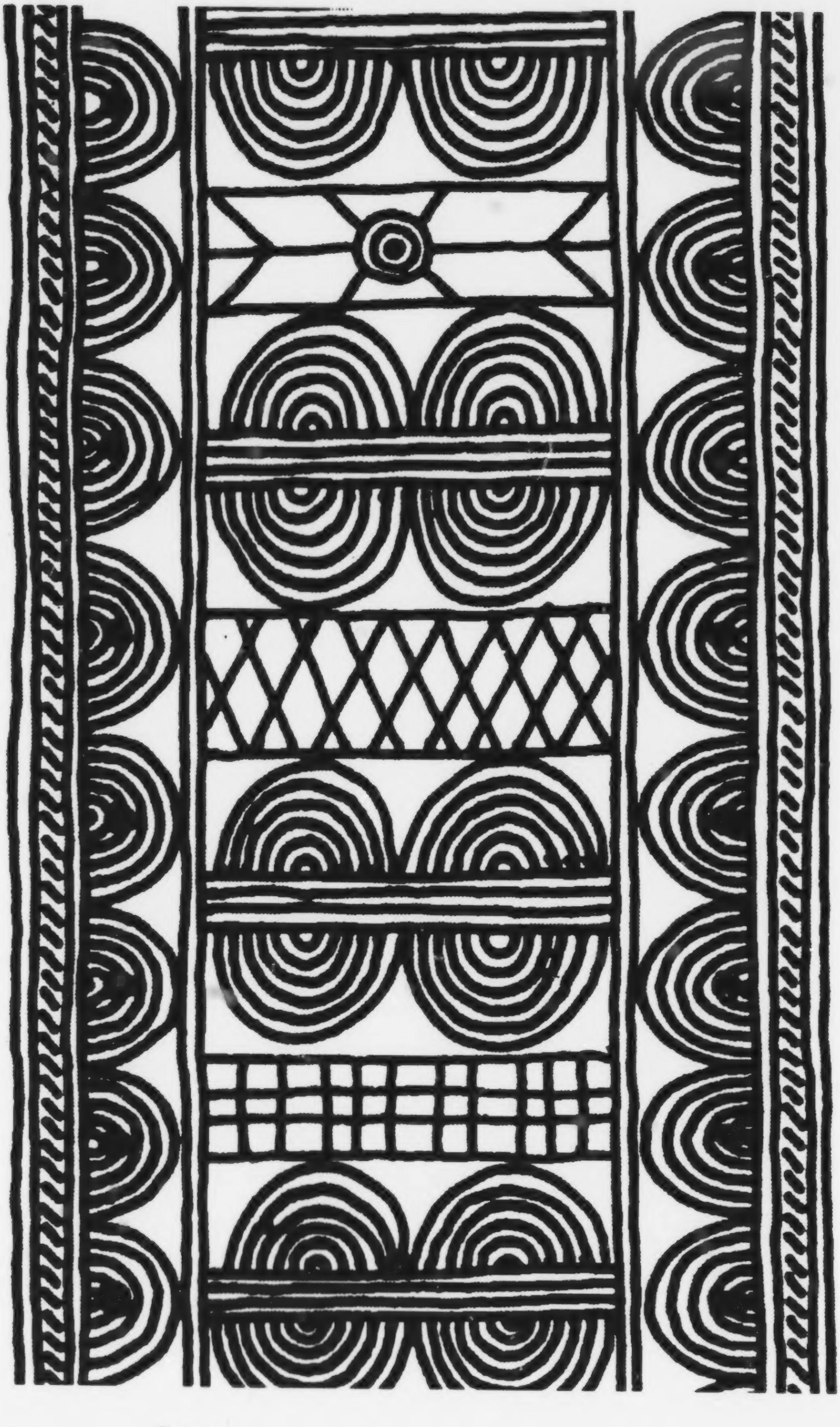
9. Journals—Give the children time to put their surveys in their journals and to make entries about what other community members think about food and hunger and on what they've learned about doing a survey.

MODIFICATIONS

For younger students, limit the surveys to five or six questions.

For older students, expand the number of questions to sixteen to twenty. Have each child survey five others, at least two of whom are not family members.





GAMES

16.

From habitat tag to quiz-shows, games can help motivate students, break up lectures, and serve as an entertaining transition between one unit and another. They can also promote environmental learning when focused on specific knowledge, thinking skills, concepts, and attitudes.

As with all activities, it's important to establish your objectives before creating a game. It's also important to know how you will evaluate your students' performances. Although it's great to break up traditional learning with entertaining games, it's important not to confuse fun with learning. With some games, students are much more interested in "winning" than they are in learning, and you have to be careful not to overuse games or make them too contrived and complicated that students miss the point. It's best to strive for fun *and* learning.

We've included three examples of games that you can adapt. The first is "Pollution Bingo," which can help students learn and review vocabulary words related to pollution and is a great activity for TEFL (Teaching English as a Foreign Language) classes. You play by reading a definition and have students find the word on their bingo sheets and cover it with a bean or pebble. (The students can make their own sheets by cutting out the squares and pasting them on cardboard.) The first person that gets a row across, down, or diagonally wins. There are many variations on the bingo theme, including picture bingo, animal characteristic bingo, and environmental math bingo. The second game, "Mammal Know-It-All" is great for group competition and unit review and is based on the popular U.S. gameshows: *Jeopardy* and *Concentration.* And the last example is a running game to help students understand more about bats and echolocation.

In addition to adapting games from the U.S. to your country, we suggest that you talk with your colleagues to find out about local games that might be adapted for use with environmental themes.

ACTIVITIES IN THIS SECTION

1. **POLLUTION GLOSSARY**, reprinted with permission from *Ranger Rick's NatureScope: Pollution—Problems and Solutions* published by the National Wildlife Federation (1990).
2. **MAMMAL KNOW-IT-ALL**, reprinted with permission from *Ranger Rick's NatureScope: Amazing Mammals—Part I* published by the National Wildlife Federation (1986).
3. **BAT AND MOTH**, reprinted with permission from *Ranger Rick's NatureScope: Amazing Mammals—Part II* published by the National Wildlife Federation. Original activity published in *Sharing Nature With Children* by Joseph Cornell, Ananda Publications (1979).

POLLUTION BINGO

OBJECTIVE:
Match words and definitions related to pollution.

AGES:
Intermediate

SUBJECTS:
Language arts

MATERIALS:
Copies of definitions and bingo sheets (see sample on page 310)

You can help students learn pollution vocabulary words by playing "Pollution Bingo." Number the definitions on pages 308 and 309 in a random order (not in alphabetical order). Then read the definition of the first word and ask the students to place a marker over the word that matches the definition. The first person to cover a row, either horizontally, diagonally, or vertically, wins. Check the winner by re-reading the definitions with the whole group.

GLOSSARY

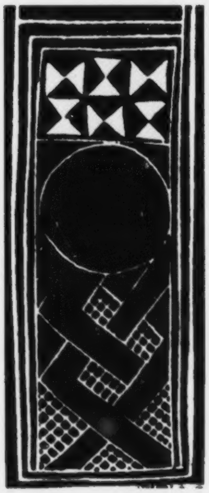
ACID RAIN: precipitation that forms in the atmosphere when certain pollutants mix with water vapor. Acid rain, more accurately called *acid deposition,* can be in the form of rain, snow, sleet, hail, fog, or dry particles. The major sources of acid rain are sulfur dioxide and nitrogen oxide emissions from fossil fuel-burning power plants and motor vehicles.

BIODEGRADABLE: having the ability to be broken down into simpler components by living organisms.

CHLOROFLUOROCARBONS (CFCs): chemicals that are used to produce plastic foam, coolants, and many other products. CFCs are the major cause of ozone depletion and are also one of the major greenhouse gases.

FOSSIL FUELS: coal, oil, and other energy sources that formed over millions of years from the remains of ancient plants and animals. Fossil fuel use is a major cause of pollution.

GLOBAL CLIMATE CHANGE: the predicted change in the earth's climate brought about by the accumulation of pollution in the atmosphere. The effects of global climate change could include altered weather patterns and rising sea levels.



GREENHOUSE EFFECT: the trapping of heat by gases, such as carbon dioxide, in the earth's atmosphere.

GROUNDWATER: water that fills the spaces between rocks and soil particles underground. Groundwater is replenished when rainwater trickles through the soil. *Surface water,* such as lakes and rivers, is often replenished by groundwater.

LEACHING: the process by which materials on or in soil are dissolved and carried by water seeping through the soil. Leaching may contaminate groundwater supplies.

OZONE: a form of oxygen. *Low-level ozone,* the main ingredient in smog, if found near ground level and is produced when sunlight stimulates a reaction between pollutants. The *ozone layer* is a protective layer of ozone high in the earth's atmosphere that filters out much of the sun's harmful ultraviolet radition. The *ozone hole* is the thinning of this layer caused by the release of chlorine atoms from chemicals such as CFCs.

PCBs (POLYCHLORINATED BIPHENYLS): chemicals that can build up to toxic levels in animal tissue.

POINT POLLUTION: pollution that comes from a particular source, such as from a factory or sewage treatment plant. *Nonpoint pollution,* which doesn't come from a single, identifiable source, includes materials that wash off streets, lawns, farms, and other surfaces.

POLLUTION: a human-caused change in the physical, chemical, or biological conditions of the environment that creates an undesirable effect on living things.

RENEWABLE RESOURCE: a resource that can be replaced through natural processes if it is not overused or contaminated. For example, sunlight and trees are renewable resources. *Nonrenewable resources* are in limited supply and cannot be replenished by natural processes, at least not for thousands of years. Fossil fuels are a nonrenewable resource.

RISK ASSESSMENT: a process that analyzes the short- and long-term risks posed by certain technologies.

RUNOFF: water, including rain and snowmelt, that runs off the surface of the land and into rivers, streams, and other water supplies. Runoff from farms, lawns, golf courses, and other development often carries traces of fertilizers.

SMOG: low-level ozone, soot, sulfur compounds, and other pollutants in the atmosphere that cause poor visibility and create hazardous conditions for living things.

SOLID WASTE: discarded solid or semi-solid material, such as paper, metals, and yard waste. The *solid waste stream* is the sum of all the solid waste that is continuously thrown away.

SUSTAINABLE DEVELOPMENT: development that uses resources in an efficient way and without destroying the basis of their productivity. For example, sustainable agricultural practices avoid the use of pesticides and chemical fertilizers that can pollute the soil and water.

TOXIC: a poisonous substance.

POLLUTION BINGO

HAZARDOUS WASTE	NON-POINT POLLUTION	ATMOSPHERIC OZONE	RUNOFF	SULFUR DIOXIDE
LEVEL OZONE	SMOG	GROUND WATER	PESTICIDES	FREE
POINT POLLUTION	POLLUTION	FREE	PCBs	NON BIO-DEGRADABLE
ACID RAIN	FOSSIL FUELS	RENEWABLE RESOURCE	BIO-DEGRADABLE	CARBON DIOXIDE
SOLID WASTE	GREENHOUSE EFFECT	CFCs	NON-RENEWABLE RESOURCE	LEACHING

MAMMAL KNOW-IT-ALL

OBJECTIVE:
Describe several ways mammals have influenced our lives.

AGES:
Intermediate, advanced

SUBJECTS:
Science, social studies

MATERIALS:
Construction paper, thumbtacks or pushpins, bulletin board, envelopes, index cards, markers, tape, chalkboard or easel paper

Here's a fun and challenging team game to help your kids review the many ways mammals influence our lives. The game is played something like the U.S. TV program "Concentration." Team members must correctly answer a mammal-related question and then try to solve a mammal rebus. (See examples on page 312.)

SETTING UP THE GAME BOARD

1. Tape several pieces of construction paper or easel paper together to form a large sheet about 35x45" (88 x 113 cm). (The size of the paper will depend on the size of envelopes you use.)
2. Choose one of the rebuses shown here or make up your own and draw it in easy-to-read letters and pictures across the sheet. (The rebus can be a famous quote relating to mammals, a type of mammal, a famous person that studies mammals, a famous mammal saying, or anything that is mammal-related.)
3. Using thumbtacks or pushpins, attach the sheet to a bulletin board and then attach 24 envelopes in four vertical columns across the board. (There should be six envelopes in each column.) The rows of envelopes should cover the entire rebus. (You can use standard envelopes or make your own using colored construction paper.)
4. Write each of these numbers - 10, 20, 30, and 40 - on a square of construction paper. Then tack the numbers, in order, above the columns of envelopes. These numbers indicate the point value for the questions in each column.
5. Write each of these categories on a piece of construction paper and tack to the left side of each row:
    - Mammal Pets
    - Famous Mammals
    - Mammals Around the World
    - Mammals in Art, Music, Language, and Literature
    - Endangered Mammals
    - Mammals in History
6. Now copy each question listed at the end of this activity (we've included two sample sets) on an index card and insert the cards in the appropriate envelopes. (You should write the answers on the front of each card.) The questions in each row should get progressively harder, with the ones in the 40-point column being the toughest.

    Note: Adjust the questions and categories to fit the needs of your group.

HOW TO PLAY

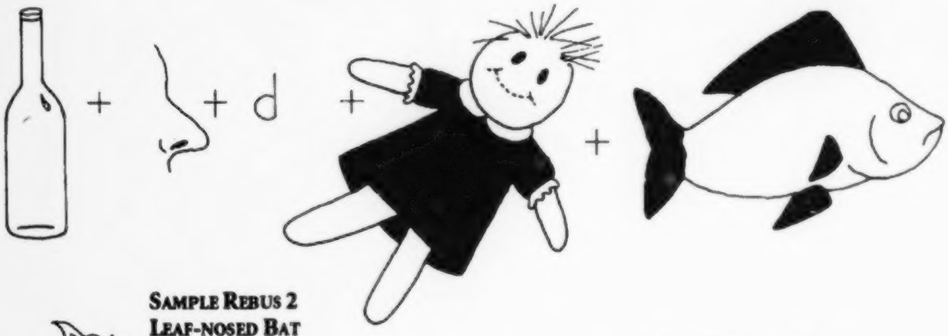
Divide your group in half and have each team choose a captain (or appoint one). Roll dice, draw straws, or spin a spinner to see who goes first. Explain that a message about mammals is hidden under the envelopes on the game board. (Make sure everyone understands what a rebus is by drawing a simple example on a chalkboard or large sheet of easel paper.)

Point out the different categories and point values and explain that the team with the most points at the end of the game wins. Also mention that there is a 100-point bonus for correctly solving the rebus. (The game is over when a team correctly solves the rebus.)

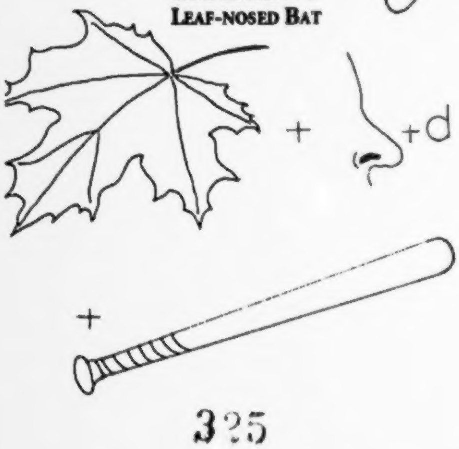
To play, have one person on the first team pick a question. (For example, he or she might say, "Mammals in History for 40 points.") Read the question to the team and give them one minute to come up with an answer. Only the team captain can officially answer, but he or she should first confer with the whole team. If the team answers the question correctly, they get the point value of the question. Then remove the envelope that contained the question, exposing part of the rebus underneath. Let the team try to guess the mystery message.

If a team misses a question, they don't score any points and the question goes back into the envelope for another try. Then it's the other team's turn. A team can try to guess the rebus only after its captain has answered a question correctly and that envelope has been removed from the board. (When a team misses a true/false question, remove the envelope, but do not give the other team a chance to guess the message. They must first answer another question correctly before guessing.)

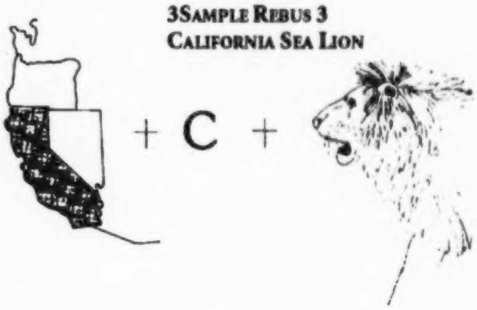
SAMPLE REBUS 1
BOTTLE-NOSED DOLLPHIN



SAMPLE REBUS 2
LEAF-NOSED BAT



3SAMPLE REBUS 3
CALIFORNIA SEA LION



MAMMAL QUESTIONS

SET 1

Mammal Pets

10: What mammal pet has a split upper lip, often eats garden vegetables, and can weigh up to 15 pounds (7 kg)? (rabbit)
20: What mammal is the most common pet in the United States? (cat)
30: What mammal was probably the first tamed for a pet? (dog)
40: What mammal pet is native to Asia, lives in the desert, and doesn't need to drink water? (gerbil)

Famous Mammals

10: Name a famous mammal that has appeared in a book. (Black Beauty, Lassie, Old Yeller, Big Red, Moby Dick, and so on)
20: What famous cartoon mammal is over 50 years old and is related to a beaver? (Mickey Mouse)
30: What famous masked mammal lives in Deep Green Wood and helps protect our environment? (Ranger Rick)
40: What famous TV star is related to a wild boar and has a best friend that is an amphibian? (Miss Piggy)

Mammals Around the World

10: What Australian mammal is the mascot for an Australian airline and feeds only on eucalyptus leaves? (koala)
20: What African mammal weighs up to 14,000 pounds (6300 kg), lives on grassy plains, has huge incisors, and makes a loud trumpeting sound when in danger? (African elephant)
30: What South American mammal has a name that begins with a double consonant and is related to camels? (llama)
40: What mammal, found in Europe, is covered with sharp spines and rolls up into a tight ball to defend itself? *Hint:* This mammal was used in the croquet game in *Alice in Wonderland*. (hedgehog)

Mammals in Art, Music, Language, and Literature

10: What mythical mammal looks like a horse but has one twisted horn on its head? (unicorn)
20: Think up a phrase or saying that is about mammals. (blind as a bat, eat like a pig, quiet as a mouse, and so on)
30: Name a song or a musical group that is named after a mammal or has something to do with mammals. ("Bingo," "Old MacDonald Had a Farm," "Mary Had a Little Lamb," The Monkees, Stray Cats, and so on)
40: Name a poem, nursery rhyme, or story that has something to do with mammals. ("Hey Diddle Diddle," "I Went to the Animal Fair," "The Cat in the Hat," and so on)

Endangered Mammals

10: True or False: Congress has passed a law that helps protect endangered species. (True—the Endangered Species Act)
20: What are two reasons that some mammals become endangered? (loss of habitat, poisoning, commercial hunting, poaching, and so on)
30: Name an endangered mammal that lives in the ocean. (humpback whale, gray whale, manatee, and so on)
40: Name two mammals in North America that are threatened or endangered. (gray wolf, grizzly bear, black-footed ferret, Delmarva fox squirrel, Florida panther, and so on)

Mammals in History

10: Name three ways mammals have been important to people throughout history. (they've provided food, clothing, shelter, transportation, and so on)
20: Name three mammals that have helped people "get around." (horse, camel, llama, donkey, ox, elephant, sled dog, seeing-eye dog, and so on)
30: What mammal was responsible for spreading the fleas that carried the Bubonic Plague, or Black Death, throughout parts of Europe during the Middle Ages? (black rat)
40: Name three mammals that are now extinct. (saber-tooth cat, mammoth, mastodon, dire wolf, and so on)

SET II

Mammal Pets

10: Which mammal pet is called "man's best friend"? (dog)
20: Thoroughbred, Arabian, Clydesdale, and Appaloosa are breeds of what domestic mammal? (horse)
30: Which popular pet is related to these wild mammals: ocelet, lynx, and cougar? (house cat)
40: Name three wild members of the dog family. (fox, wolf, coyote, jackal, dingo, and so on)

Famous Mammals

10: What famous mammal says, "Only you can prevent forest fires." (Smokey the Bear)
20: What is the name of the hooved mammal whose rider was a masked man? (Silver)
30: What female gorilla has learned to communicate with people in sign language? (Koko)
40: Name the famous albino gorilla that now lives in a zoo in Spain. (Snowflake)

Mammals Around the World

10: What black and white hooved mammals live in herds on the African plains? (zebras)
20: What African mammals live in social groups called prides? (lions)
30: What semi-aquatic Australian mammal lays eggs? (platypus)
40: Name three types of pouched mammals that live in Australia. (kangaroo, wombat, wallaby, koala, and so on)

Mammals in Art, Music, Language, and Literature

10: What farm mammal did Little Bo-Peep lose? (sheep)
20: What mammal from *Alice in Wonderland* always complains, "I'm late, I'm late! For a very important date!" (the white rabbit)
30: What mammal most likely produced Little Miss Muffet's curds and whey? (cow)
40: What saying describes calling for help when you don't really need it? ("crying wolf")

Endangered Mammals

10: What black and white endangered mammal feeds on bamboo? (giant panda)
20: What mammal in the dog family used to live in almost every habitat and region of the world north of the equator until it was hunted and poisoned almost to extinction? (wolf)
30: What weasel-like mammal preys on prairie dogs and lives in their burrows? *Hint:* This mammal has a black mask and black feet. (black-footed ferret)
40: What endangered marine mammal migrates each year along the Pacific coast of North America? (gray whale)

Mammals in History

10: What mammal has been used for thousands of years to carry people and supplies across deserts? (camel)
20: What shaggy-furred mammal used to roam the U.S. plains in huge herds? (bison)
30: What African primate was sent into space before humans? (chimpanzee)
40: What was the first mammal to orbit the earth? (dog)

BAT AND MOTH

OBJECTIVE:
Describe how insect-eating bats catch prey in the dark.

AGES:
Primary

SUBJECTS:
Science

MATERIALS:
Blindfolds, pencils, paper

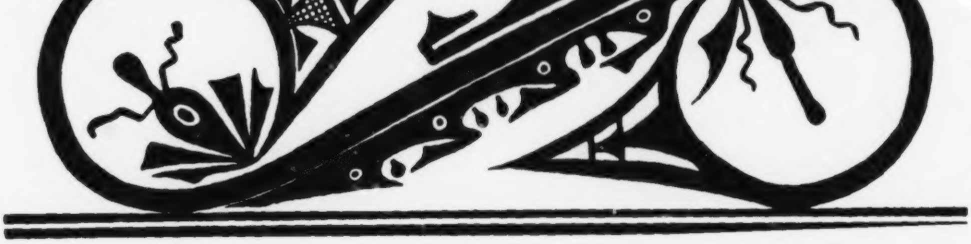
In this game, your kids can simulate how bats use echolocation to catch moths and other insects. (For more about echolocation, see "Ears in the Dark" in *Ranger Ricks' NatureScope Amazing Mammals—Part II.*) To play, have the kids form a circle about 10-15 feet (3-4.5 m) across. Choose one member of the group to play the role of a bat. Blindfold the bat and have him or her stand in the center of the circle. Then designate three to five other children as moths and have them also come to the center. The object of the game is for the bat to try to tag as many moths as possible. Both the bat and moths can move, but they must stay within the circle. (Once a moth is tagged, he or she should go outside the circle and sit down.)

Whenever the bat calls out "bat," the moths have to respond by calling back "moth." Tell the moths that every time they hear the bat call "bat," it simulates the bat sending out an ultrasonic pulse to see what's in its path. The pulse bounces back to the bat, simulated by the moths calling out "moth."

The bat must listen carefully, concentrate to find out where the moths are, and try to tag them. To add more excitement, you can designate two children to be bats at the same time. Just watch to make sure the two bats don't collide with each other. You might want to pick a short and a tall child, so they don't bump heads.

As another variation, you can add obstacles by designating several children to play trees. When the bat calls out "bat," the moths must call out "moth" and the trees must call out "tree." If a bat runs into a tree as it tries to tag a moth, the bat is out.

(Idea reprinted with permission from Sharing Nature with Children *by Joseph Cornell, Ananda Publications, 1979.)*



BRANCHING OUT: BAT MATH

As a challenge, see if your students can figure out the following math problem. The answer is explained below. (Math problem reprinted with permission from *Rhode Island Naturally: Mammals,* by Roger and Gail Greene, Audubon Society of Rhode Island, 1982.)

PROBLEM:

How many mosquitoes does a little brown bat eat during one summer?

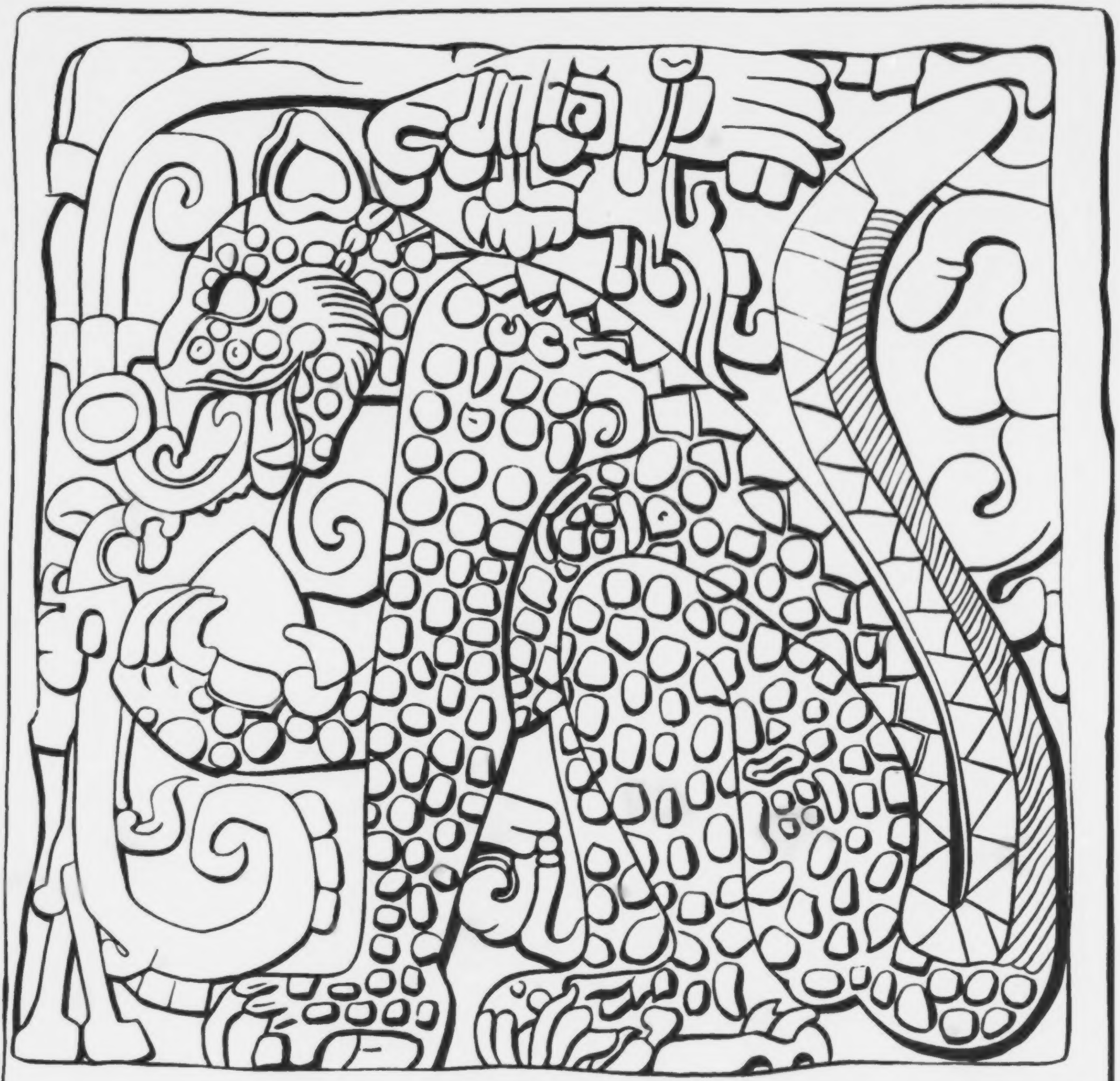
GIVEN:

- A bat eats approximately 4 grams of insects in one night.
- At least 20% of a little brown bat's food consists of mosquitoes.
- A mosquito weighs approximately 2.2 milligrams.
- The summer season lasts for approximately 90 days.

ANSWER:

1. To find out how much of a little brown bat's nightly food consists of mosquitoes (in grams): 4 grams of food per night x .20 (mosquitoes are 20% of a bat's diet) = .80 grams of mosquitoes per night
2. To find out the number of mosquitoes eaten by a little brown bat in one night:
   - Convert .80 grams of mosquitoes to milligrams—.80 x 1000 (there are 1000 milligrams per gram) = 800 milligrams of mosquitoes per night
   - Divide the number of milligrams of mosquitoes by the weight of one mosquito—800 milligrams of mosquitoes per night divided by 2.2 milligrams per mosquito = 364 mosquitoes eaten in one night
3. To find out how many mosquitoes are eaten during the three-month summer season:
   - Multiply 90 nights by the number of mosquitoes eaten in one night— 90 x 364 = 32,760 or about 33,000 mosquitoes eaten by one little brown bat during the summer

Note: Explain to the kids that this number is just an approximate figure. Also explain that most scientific research is recorded in metrics, not English measure.



THE URBAN EXPLOSION

17.

According to the United Nations, by the year 2025, the world population will climb to more than 8.2 billion. And most of the increase will take place in urban areas. Many experts anticipate that the urban explosion will:

- Take place at proportionately higher rates in developing country urban populations
- Take place throughout urban areas, from market towns to megacities
- Shift the location of poverty from rural to urban areas. (By early next century, more than 57% of the world's poor will be living in cities.)
- Increase urban environmental problems throughout the world, including increased air and water pollution, solid and toxic waste disposal problems, traffic congestion, noise pollution, and other serious problems

> *Impact per Person x Number of Persons = Total Environmental Impact*
>
> —Paul Ehrlich

ACTIVITIES IN THIS SECTION

1. **MICRO URBAN INVESTIGATION, BRAINSTORMING ON ENVIRONMENTAL TOPICS, DECIDING IF YOU AGREE OR DISAGREE,** and **THE URBAN ENVIRONMENT AND POOR NEIGHBORHOODS,** reprinted with permission from *Educational Module on Environmental Problems in Cities* published by Unesco-UNEP International Environmental Education Programme, Environmental Education Series #4.
2. **VANDALISM: DISORDERED COMMUNICATIONS,** reprinted with permission from *How To Interpret Natural and Historical Resources* by Leslie Dawson published by World Wildlife Fund, Latin American and Caribbean Program (1992).
3. **FLOODED STREETS,** reprinted with permission from *Floods and Drought,* an educational packet published by the Centre for Environment Education, Thaltej Tekra, Ahmedabad 380 054, India.

FOUR URBAN ACTIVITIES

OBJECTIVES:
Investigate urban environmental issues (see each activity for specific objectives)

AGES:
All

SUBJECTS:
Social studies

MATERIALS:
See each activity for materials

The following four activities focus on investigating urban communities and urban environmental problems. Adapt the activities to fit the needs of your students and community. For additional information about urban issues, you can write to Unesco-UNEP International Environmental Education Programme to request their module on cities.

1. MICRO URBAN INVESTIGATION

EMPHASIS: Community inventory and reporting

TIME: Several days

MATERIALS: Map of the city, poster paper, and local newspapers

OBJECTIVES: List positive environmental qualities of a neighborhood or part of the local community. List negative environmental qualities of the area. Explain verbally how positive and negative aspects of an area affect the rest of the city.

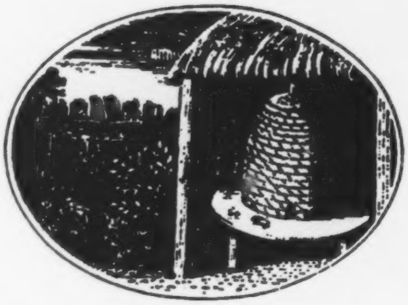
ACTIVITIES:

1. Visit a neighborhood or small part of the local community. Inventory the area:
    a. Determine what kinds of people live in the area. Note signs of children and types of housing (single-family homes, apartments, two-family homes, etc.).
    b. Types of businesses, parks, vacant land, construction, etc., in the area.
    c. List the positive aspects of the neighborhoods, both physical and visual.
    d. List the negative aspects of the environment, physical and visual. Pay attention to traffic congestion, decaying housing, quality of yards and streets, litter, etc.
2. Prepare a presentation or write a full report discussing the living environment of the study area. Consider the following:
    a. What are the neighborhood's positive and negative aspects?
    b. How do the positive aspects affect the rest of the community?
    c. How do the negative aspects affect the rest of the community?
    d. Which environmental assets have potential for serving as building blocks to improve the livability of this community?

   e. What problems exist because of other factors in the community?
   f. What environmental problems in this community are related to regional environmental problems?

3. Make charts and drawings of alternative uses of buildings or land in the area. Cut ads designed to sell or rent housing in the community (in the area selected if possible) and create a large collage of the ads for display.

4. Using the report and the visuals, prepare a report of major concerns about the study area. Determine an audience that might be interested in the report. Consider a government agency, a community, or church leaders. Make a presentation to the group to point out environmental improvements that could be made in the study area.



2. BRAINSTORMING ON ENVIRONMENTAL TOPICS

EMPHASIS: Developing alternative solutions

TIME: 30 minutes

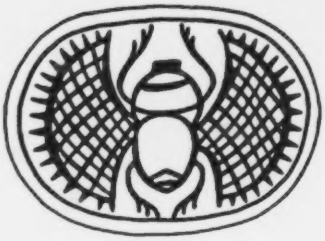
MATERIALS: List of brainstorming topics, chart paper, and markers

OBJECTIVES: Generate, in writing, alternatives to a community environmental problem. Evaluate, by discussing with a group, suggested alternatives related to the environmental issue being discussed.

ACTIVITIES:

1. Form the class into groups of four or five.
2. Provide each group with a problem area about which to generate alternative solutions.
3. Possible problem areas (appropriate for the local area):
   a. Urban housing
   b. Community recreation facilities and programs
   c. Solid waste management (school, community, home)
   d. Urban mass transportation
   e. Community water quality.
4. Provide each group with chart paper and markers to record the alternatives generated.
5. Give each group 20 minutes to develop alternatives. One member of the group records the alternatives.
6. The recorders of each group share with the other groups their list of alternatives.

7. During the sharing activity additional alternatives can be added to each group's list.
8. Discussion questions:
    a. How realistic were the alternatives generated by your group to the topic area of discussion?
    b. How might the group have functioned more effectively?
    c. Were there any new strategies gained by sharing your group's alternatives with the rest of the class?



3. Deciding if You Agree or Disagree

Emphasis: Values clarification

Time: 20-30 minutes

Materials: Five chairs or desks

Objectives: Discuss how different individuals have different ideas about the nature of environmental problems. Discuss how different individuals and agencies have different ideas about the importance of environmental problems and methods of solving them.

Activities:

1. Arrange five chairs or desks in a row, leaving several feet in between them so as to form four separate areas along a line. These chairs represent positions ranging from agreement to disagreement.
2. Explain to the class that you are going to read several value-related statements for which they are to respond by walking to the area that represents their position on the statements.
3. After each question, have a few students share their reasons for the particular positions.
4. Continue this same procedure for other statements.
5. Let the class or yourself suggest other value statements.

4. The Urban Environment and Poor Neighborhoods

Emphasis: Community exploration and awareness

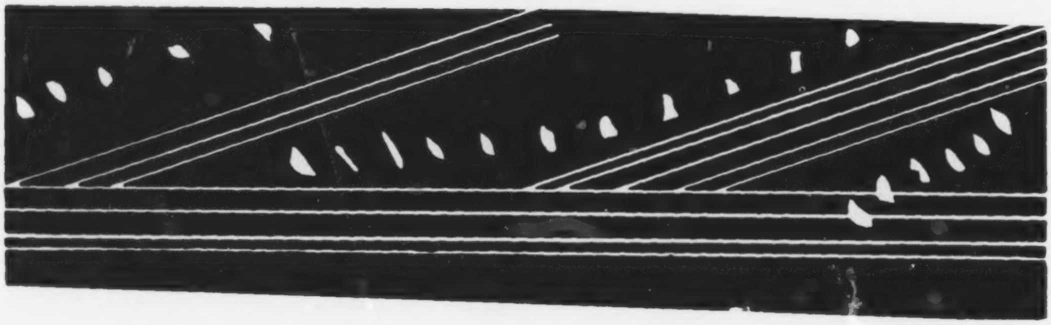
Time: Several days

Materials: Map of the metropolitan area (for each student if possible); paper and pencil

Objectives: Describe, in writing, ways the poorest people in the city are affected by environmental degradation. Discuss problems which result in the poor being ineffective in correcting environmental problems.

ACTIVITIES:

1. Get a map of the metropolitan area and mark the location of four undesirable living areas, including areas where industries or other enterprises affect the quality of the environment such as a steel mill, auto plant, sewage treatment plant, etc. The telephone book might assist in finding them.
2. For each area list all the disadvantages of living there, particularly the disadvantages of living close to the industries or plants.
3. For each area determine the type of housing. Indicate whether housing is single, two-family or multiple-family dwellings. You can visit the areas or ask someone familiar with the area.
4. Mark the areas and industries on a large map.
5. Discuss the type of housing and disadvantages of living near each location.
6. Write a paper discussing the following questions:
    a. Why do people live near industries or other enterprises that might affect the quality of their lives?
    b. What economic segment of the population generally lives in the locations identified?
    c. What educational level is generally found in this group of people?
    d. Why are these people limited in the ways they can improve the quality of their lives?
    e. In what ways do these people pay a greater cost than others living farther away from these offending industries?
    f. What are some possible ways the quality of life in these areas can be improved?
7. Develop a plan to upgrade one area. Make a presentation on your idea to the class.



VANDALISM: DISORDERED COMMUNICATIONS

OBJECTIVES:
Discuss the motivations for vandalism, some negative consequences of vandalism, any local instances of vandalism, and their impact on the community. Describe several alternatives to a vandal's method of communication.

AGES:
Intermediate, advanced

SUBJECTS:
Social studies

MATERIALS:
Chalkboard and chalk or a large pad of newsprint and markers, slides of local vandalized sites

Many environmentalists identify vandalism as a major blemish on the environment in Latin America and the Caribbean. Quite possibly some of your visitors have vandalized public places. But simply telling them that "vandalism is-and therefore vandals are-bad" would probably have no impact. In this exercise, participants can explore the reasons that people vandalize public objects and places. The activity then asks participants to suggest other ways to accomplish the same ends.

It is important for the environmental educator in this activity to assume a nonjudgmental, almost academic, attitude about the subject. Only in this way will participants feel free to discuss it.

PROCEDURE

1. Ask each participant to name one thing in his or her environment that he or she considers beautiful, or as having special meaning. Tell the participants that this activity is about such things and about why people might willingly ruin the very things they claim to value. Warn the participants that they may feel uncomfortable talking about this topic, but encourage them to think hard and to say what they think. Assure them that no one will be criticized for his or her observations.

2. Ask if anyone knows the word that describes behavior that defaces or destroys property. (vandalism) Write the word and its definition on a chalkboard or sheet of newsprint.

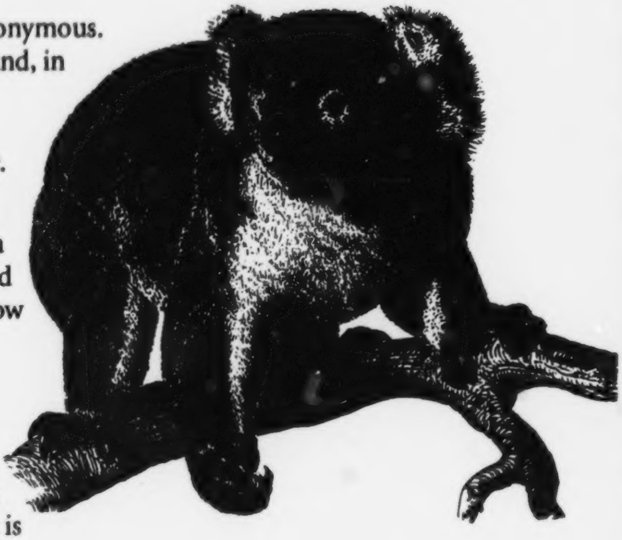
3. See if the participants can identify some examples of vandalism in their environment, and then list these.

4. Think back to the beautiful or special things named by members of the group in step 1. Are any of these included in the list you just wrote? (If you have slides showing examples of vandalism, this would be a good time to show them.)

5. Go through the list, and for each example ask, "Why do you think the vandal did this?" On the chalkboard or newsprint, note the various reasons suggested. (The participants may need some help from you.) With some discussion they may come up with motivations such as love (scribbling "Antonio loves Juanita" on a cement wall), anger (creating a nuisance or an eyesore, such as tossing a bucket of paint on a monument), making a political statement, leaving witty or obscene messages (as in bathroom graffiti), and theft.

6. Tell the participants that all of these types of vandalism, except for theft, have four things in common. Can they identify these factors? The first two factors are that all are attempts to communicate something and all are located in places where people are more or less

forced to see them—on beautiful objects, on historical monuments or relics, or on objects such as walls and highway overpasses that many people pass by every day. That is the reason for the great irony of vandalism— some of the most special things in our environment may be used for the communication of ugly, irrelevant (to the object), or short-lived ideas.



The third factor is that a vandal's message is generally anonymous. Most communities punish vandals once they are identified, and, in some countries, writers of political messages are severely punished. A fourth factor is that many, but not all, acts of vandalism are relatively permanent; they are difficult to erase.

The theft of precious objects (or even materials such as brass plaques) does not fit into the category of vandalism as a means of expression because the motivation is probably based on economic need— regardless of whether you agree with how the thief "earns" a living.

Your participants may suggest another motive for the vandalism behind such acts as the smashing of La Pieta, Michelangelo's beautiful statue in St. Peter's Basilica in the Vatican. While the vandal who did this may have been trying to say something about motherhood or organized religion, it is more likely that he was simply emotionally disturbed at the time. (Often vandalism is dismissed as an act of a crazy person, rather than a destructive attempt to communicate real ideas or feelings.) In a way, an act of vandalism is just a cheap way to make a headline.

7. Now that the participants can think of vandalism as a way of communicating an idea or a feeling, they should be able to suggest alternatives to this form of communication. For instance, a political slogan could be painted on a cloth banner and hung across the street or on private property instead of spray-painted on a public wall. Or someone who wants to make a political statement could organize a rally as another alternative.

Distribute paper and pencil to the participants. Ask them to write down three examples of vandalism in their community and what the motivation behind each example might have been. For each example, they should also suggest an alternative method for accomplishing the vandal's goal. Allow ten minutes for this.

8. Collect the papers. Read some of the alternatives to the whole group and discuss them. Would the alternatives be practical? Effective? Safe? Be prepared for some funny or outrageous suggestions.

Follow-Up Activities

1. If you will have continuing contact with the group, develop a project in the community, either addressing a message often communicated by vandals or addressing vandalism in general. Encourage students to work together with community officials.
2. Other questions to explore could be:
    - When does vandalism in the environment become terrorism?
    - How can vandalism harm a community?
    - How can vandalism harm the natural environment?
    - Can vandalism ever play a positive role?
    - How have your ideas about vandalism changed as a result of doing this activity?

3. If students or youth group members are interested in the subject of vandalism, have them write a play about it, and produce the play at a local carnival or for the school. Younger students might have an antivandalism poster contest. Posters could be displayed by local merchants, or at public libraries, markets, and other prominent locations in the community.

FLOODED STREETS

People have made tremendous progress in all fields with the help of science and technology. But this has also meant greater interference with the balance of nature. Land areas have been increasingly mismanaged and over-exploited. This has led to the deterioration of soil.

Agricultural progress has led to the excessive use of chemical pesticides and fertilizers that affect the soil. Use of heavy agricultural machinery also leads to soil becoming compact, thereby decreasing its ability to absorb and retain water.

The growing expansion of industry into agricultural lands has also led to the deterioration of the soil and water in their vicinity. The drainage pattern has been upset. The rain water does not percolate into the soil but drains directly into waterways and increases the chances of flooding. Mining also contributes to soil erosion and causes landslides.

In most areas thoughtless removal of vegetation has led to severe soil erosion by water and wind, causing in turn problems of over-siltation and flooding.

Increasing human settlements have covered much of the land with roads, buildings and other people-made structures. Constructions turn the ground into a solid impenetrable mass, making it impossible for water to seep into the soil. In towns and cities, if storm water drains are not planned or maintained, there is every possibility of the rain water causing flooding.

Most of us have the experience of wading through flooded streets after a rainfall. In the following activity students may be encouraged to give some thought to the cause of this flooding and try to trace some of the drainage patterns in their residential or school areas.

OBJECTIVES:
Observe and comment on the effect of heavy rains on human settlements.

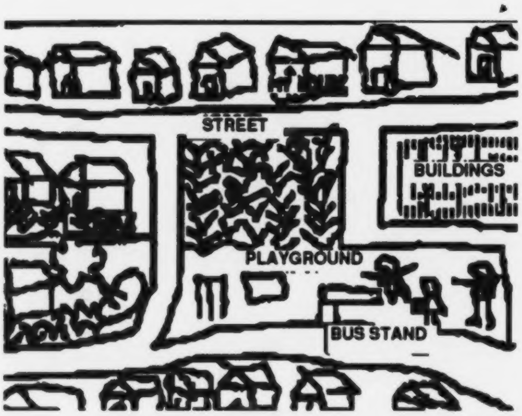
AGES:
Intermediate

SUBJECTS:
Social studies

MATERIALS:
A stick or ruler, paper, pencil and pen, color pencils, crayons

PROCEDURE

Before it rains, the students, in small groups, should take a walk in their residential areas. They should make a sketch of their residential areas showing houses, streets, etc. The sketch need not be to scale.



They should observe the different types of roads and paths in their area. (A tar road, a gravel or stone road, and an earthen road.)

The students should be asked to observe whether the drains are clean and well maintained or filled with litter.

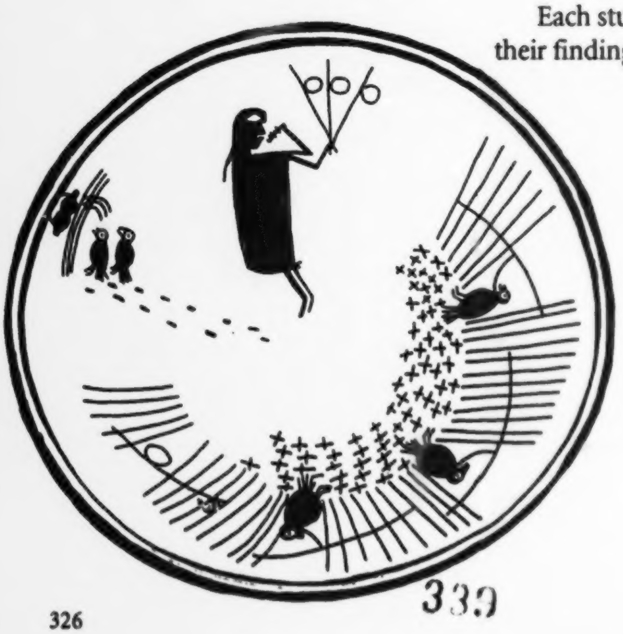
After the rain—preferably a heavy rain—the students should take another walk, in the same area of which they have prepared the sketch. They should observe the way the rain water flows away from the houses and the roads into the drains.

Are the roads flooded after the rains? If so, why?

The following questions may be given to them as clues to what to look for:

- Does the rainwater form puddles? Where?
- Where does the rainwater collect? At the sides of the roads, in the middle of the road?
- Does the rainwater drain into ditches?
- If the area is well-drained, how long does the water take to get absorbed by the soil or to drain off?
- If the soil is built over and the drainage system is not good, for how long is the area flooded?
- How deep is the water in the flooded areas? (This can be seen by dipping a stick and the wet part being measured with a ruler.)
- If the soil is covered by vegetation, does it make any difference in the flooding?
- How do the people, animals, and vehicles pass through the areas filled with water?

Each student or group should be asked to submit a short report on their findings.



GETTING OUTSIDE

18.

You learn that if you sit in the woods and wait, something happens.

—Henry David Thoreau

Although it's important to take field trips to expose your students to experiences away from the school grounds, it's also important to spend time outside in your local environment, including time investigating the school grounds. There are many activities you can do in any outdoor area that can relate to every subject in the curriculum. From using the environment as a living lab to enhance your science and math studies to using it to help inspire your students to create poetry, there are many innovative ways to promote outdoor experiences with your students. In many areas around the world, urban areas are increasing so rapidly that students rarely get an opportunity to spend quality time in the out-of-doors. And many people worry that this alienation can create a feeling of separateness and disinterest in the environment.

Outdoor experiences can enhance science, language arts, history, and many other subject areas. In addition, outdoor experiences can enhance awareness about environmental issues and influence attitudes about the natural world. In this section, we've included three outdoor activities. The first takes students on a sensory hike through a forest. The second is a weather-related scavenger hunt. And the final activity is an insect-bingo hike. All can be adapted to a variety of sites and ages.

ACTIVITIES IN THIS SECTION

1. **EXPANDING SENSORY PERCEPTION**, reprinted with permission from *Project Learning Tree*, published by the American Forest Foundation and the Western Regional Environmental Education Council (1990).

2. **WEATHER SCAVENGER HUNT**, reprinted with permission from *Ranger Rick's NatureScope: Wild About Weather* published by the National Wildlife Federation (1985).

2. **INSECT BINGO** reprinted with permission from *Ranger Rick's NatureScope: Incredible Insects* published by the National Wildlife Federation (1984).

EXPANDING SENSORY PERCEPTION

OBJECTIVE:
Become aware of senses and be able to describe how the use of one's senses may increase appreciation and understanding of the environment.

AGES:
Kindergarten-6th grade

SUBJECTS:
Health, science, language arts, and humanities

MATERIALS:
Blindfolds, drawing materials, construction paper or cardboard, scissors, tape recorder, blocks of aromatic wood (optional)

Blindfold students, a few at a time, and ask them to feel the bark of different trees. You may want to take the students for a walk in a park, leading them carefully to different trees that have different bark textures.

Ask the students to feel the textures of leaves and needles from different trees. This can be done either in the classroom with examples of different types or outside in a natural setting.

Repeat this exercise without blindfolds. See if the students can identify trees, leaves, and needles they felt while blindfolded.

Caution: Supervise this activity very closely while the students are blindfolded.

VARIATIONS

1. Take students to a place where there are several varieties of living things in close proximity. Ask all students, except one, to close their eyes. Then ask the student whose eyes are open to describe a living thing or part of a living thing using any or all of his or her senses. When the description is finished, ask the remainder of the students to open their eyes and attempt to identify the living thing described.
2. During a walk outside, ask your students to find a plant and to describe its color, how it feels, how it smells and how it sounds. As added motivation, see who can find the fuzziest leaf, the greenest leaf, the biggest plant, the noisiest bush. You might remind them that trees are plants.
3. If a wooded area is nearby, take students on a walk through the woods during and/or immediately after a rainfall or snowfall. Ask them to describe the effects of the rain or snow on the entire forest as well as on individual plants and animals. Encourage the students to use as many of their senses as possible: How do the woods smell? How do they sound? Does it feel different to walk here now than it did before?
4. During a short walk outside, ask students to pick up a handful of soil. Ask the students to describe—either orally, in writing, or through dramatic interpretation—its smell, its feel, its colors and what they can find in it, such as sand, stones, leaves, worms and insects.
5. **SIGHT:** Take students on a walk in a local forest area or park. Ask them to record shapes, patterns, or designs they see, using a pencil or crayon.

In the classroom, ask the students to cut various geometric shapes (such as triangles, squares, or rectangles). Take these shapes on a walk and ask students to match them with similar patterns in nature.

On a walk through a wooded area, ask students to create their own color names for each shade they observe.

Sound: Take students on a walk. Ask them to record on cassette tape the sounds they like; the sounds they don't like; animal sounds they know; animal sounds they don't know; human-made sounds and natural sounds. Play the recordings in class and ask the students to identify the sounds. Ask the students to imitate the forest sounds (rustling leaves, wind in trees, thunder, rushing water, bird calls).

Smell: Collect small blocks of aromatic woods such as cedar, pine, and camphor. Ask students to smell each block as you tell them its name. When they can identify correctly each block by sight and smell, take the students to a wooded setting and blindfold them. Ask the students to try to identify the trees and other plants using only their sense of smell.

Note: You can make some woods more aromatic by wetting them. As a general rule, coniferous woods (softwoods) are more aromatic than deciduous woods. If you can't or don't want to buy them and can't find them otherwise, take care not to damage trees and other living things in gathering wood samples from forest settings. Good sources for the blocks are local furniture makers, building contractors, lumberyards, or a high school woodworking shop.

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WEATHER SCAVENGER HUNT

OBJECTIVE:
Describe several ways weather affects plants, soil, and people and other animals.

AGES:
Primary

SUBJECT:
Science

MATERIALS:
Scavenger clue sheets, bags, pencils and paper, clipboards, rubber bands, tape or glue (optional), sturdy cardboard

Take your group on a weather scavenger hunt to see how many weather-related things they can find. Use the list of clues provided to make up a clue sheet that is appropriate for your group. Some of the clues don't require any weather background, but others do.

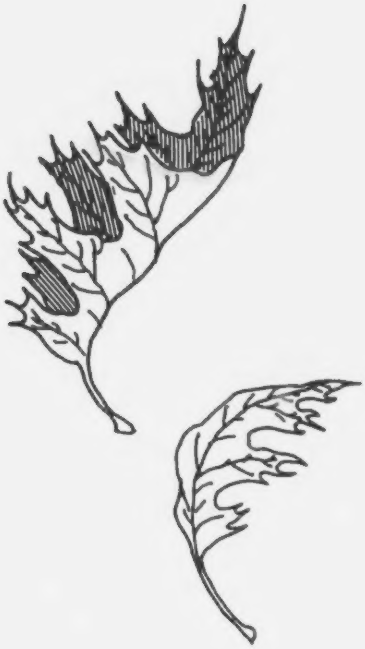
Divide your group into teams and give each team a clue sheet, a bag, a pencil, one or two sheets of paper, and a clipboard. (If you don't have clipboards, tape or glue the clue sheets to pieces of sturdy cardboard or attach with rubber bands.) Explain to the kids that they can put some of their "weather finds" in their bags. But for the clues they can't collect, they should draw or describe what they see on their blank sheets. (Young children can go on a weather scavenger hunt too—just take them for a walk and talk about some of the easier weather clues.)

Set a time for all the teams to meet back at the starting point. Then have each team show and explain what they found for each clue. Afterward, have each team return any "finds" to where the items were found.

Note: Before sending the group out, make sure to set your own scavenger hunt guidelines, such as: "Do not pick flowers, reach under logs with bare hands, or wander away from the rest of the group."

CLUES FOR WEATHER SCAVENGER HUNT

1. Something bending toward the sun
2. Something hiding from sunshine
3. Something that may become part of a cloud
4. Something that tells you the wind is blowing
5. Something left by the rain
6. A sign of an animal used in folklore to "predict" the weather
7. A bad place for a person to seek shelter during a lightning storm
8. A place where icicles might form
9. A place where weather has damaged a building
10. A good place for a person to seek shelter during a tornado
11. Sign of an animal that likes rain
12. A place to go where it's cool
13. A place where rain has moved the soil
14. A place that gets little sunshine
15. Something that bends in the wind
16. Something that won't bend in the wind
17. Something that reflects lots of sunlight
18. Something that absorbs lots of sunlight
19. Something that will soak up rain
20. Something that makes rain splatter
21. Something that protects people from rain
22. Something that uses sunlight or wind or water to work
23. Something that smells better after a rain shower
24. A good windbreak
25. Something shaped by wind or water
26. A sign of lightning damage
27. Something the color of the sky
28. Something the color of snow
29. Something that would make snow melt



INSECT BINGO

OBJECTIVES:
Describe five places where insects live. Give examples of the ways insects find food, water, shelter, and a place to lay their eggs.

AGES:
Primary

SUBJECT:
Science

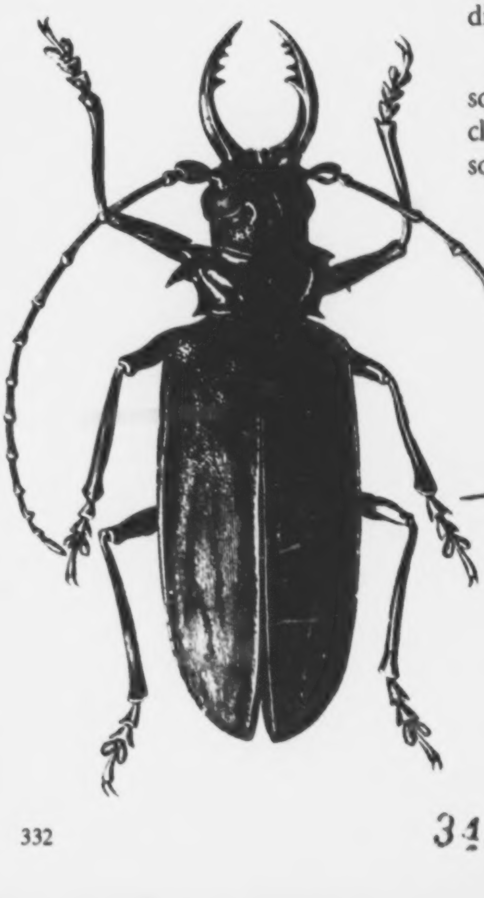
MATERIALS:
Copies of Insect Bingo chart, cardboard or heavy paper (8½ x 11), clear contact paper (optional), grease pencil (optional), scissors, pencils

Insect Bingo is an exciting way to investigate insect habitats. Make enough copies of the bingo chart on page 333 for each person in the group to have one. Also pass out scissors, glue, and cardboard. Now have each student make up a game card, or "bug board," by cutting apart the chart squares and pasting them in a new arrangement on their sheet of paper or cardboard. (Each card will have the same items, but the items will be arranged in a different order.)

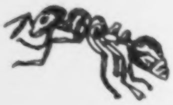
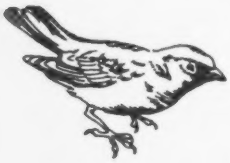
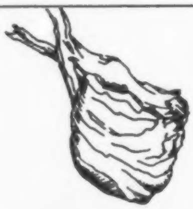
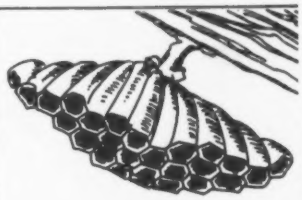
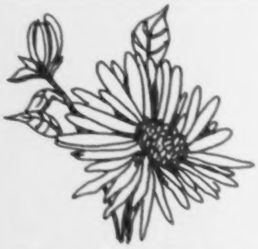
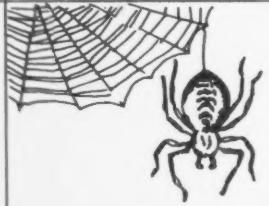
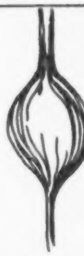
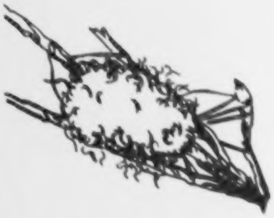
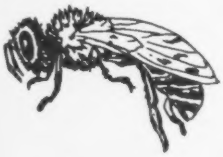
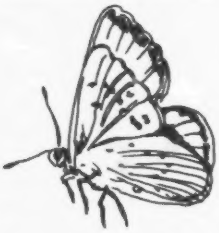
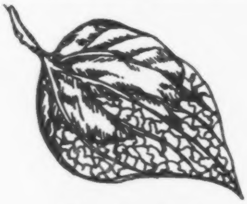
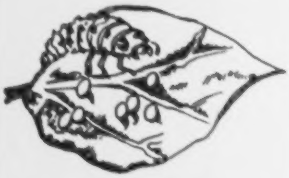
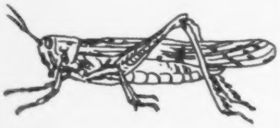
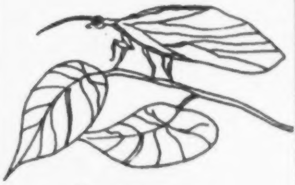
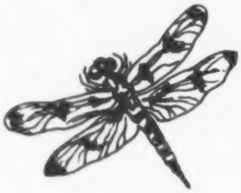
Now take a walk on a nature trail or in the schoolyard. Have the kids look for the items and insects that are shown on their sheets. When someone spots something on the sheet, discuss it in relation to an insect's habitat. For example, if a dragonfly is spotted, ask the children what it might eat or where it takes shelter in case of a storm. Or why it needs to live close to water. (Dragonflies lay their eggs in or near the water, and the nymphs that hatch live underwater in rivers, ponds, and lakes.) If someone sees an insect home, discuss how that home provides food, water, shelter, and a place to lay eggs for a particular type of insect. Also talk about the different types of insects that might live there.

Have everyone put an X over the things on his or her board as they are spotted. The first person to get a whole line crossed (up, down, diagonally) wins the game.

To make the cards permanent and reusable have the kids paste the squares onto heavy cardboard. Laminate the cards or cover them with clear contact paper. Then have them use special grease pencils to X the squares so that the Xs can be easily wiped off and the cards used again.



INSECT BINGO

 ANT	 INSECT PREDATOR	 INSECT EGG CASE	 INSECT HOME
 INSECT FOOD	 INSECT RELATIVE	FREE SQUARE	 GALL
 COCOON	 BEE	 BUTTERFLY	 INSECT DAMAGE
 INSECT EGGS OR LARVAE	 GRASSHOPPER	 INSECT CAMOUFLAGE	 WATER INSECT

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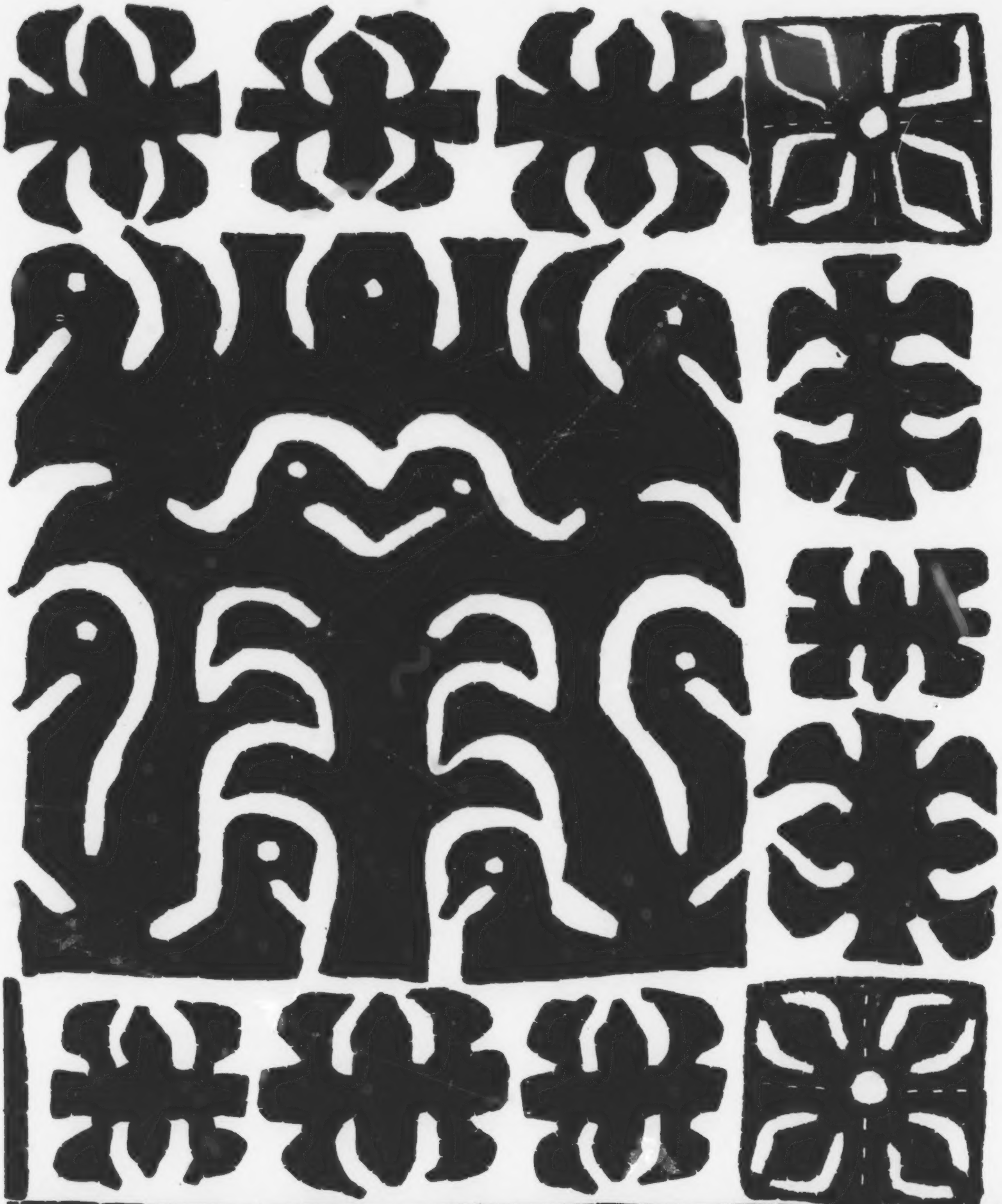

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19.

RESEARCH/GUEST SPEAKERS

> *Education is what survives when what has been learned has been forgotten.*
>
> —B. F. Skinner

There are many activities that can help your students find out more about a topic. One way is to encourage research projects that can help your students learn how to find information and improve their research skills. From using a library to interviewing experts to conducting computer searches, it's important that your students know how to find the information they need.

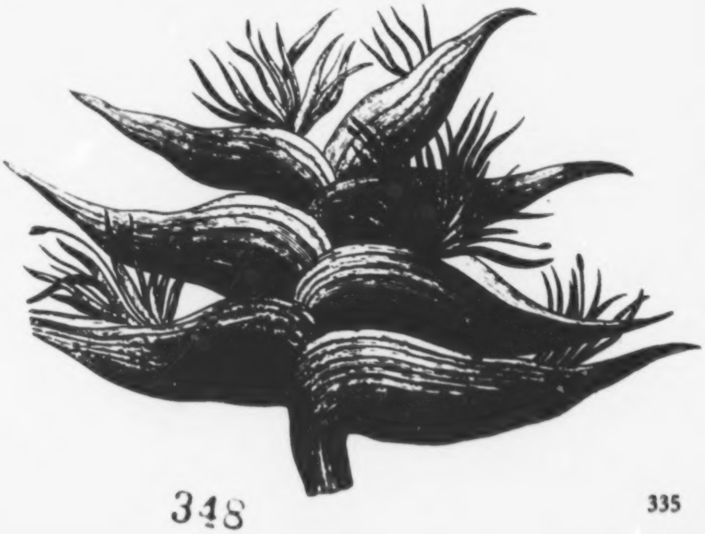
You can also invite guest speakers into the classroom. Speakers can motivate your students, encourage discussion, and bring new points of view into the classroom. When discussing controversial issues, it's important to bring in speakers who represent different sides of an issue. You might also consider inviting a panel of guests to speak about one topic. There are many resource experts in your community, including extensionists, farmers, scientists, doctors, teachers, public officials, and professors.

Guest speakers also give your students practice in creating and asking questions. Before a speaker arrives, have your students think about the types of questions they might ask and write them down. You might also want to have one or more students conduct an interview with one of the guests after the presentation.

In the research activity included here, students investigate deserts by trying to answer a series of questions. If you do not have access to a library or books, you could encourage students to investigate a topic in their community by questioning elders, women, and other experts.

ACTIVITY
IN THIS
SECTION

1. **DESERT QUEST**, reprinted with permission from *Ranger Rick's NatureScope: Discovering Deserts* published by the National Wildlife Federation (1988).



DESERT QUEST

OBJECTIVES:
Research the answers to desert-related questions. Discuss three unusual desert-related facts.

AGES:
Advanced

SUBJECT:
Science

MATERIALS:
Paper and pencils, reference books

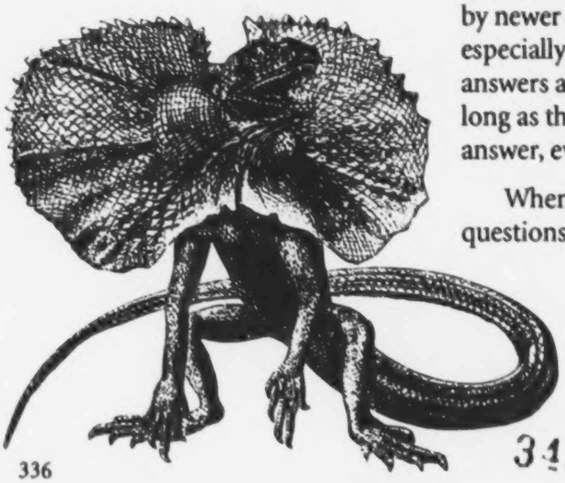
Holding a desert research contest is a great way to help your kids learn some fascinating desert facts. To get started, pass out copies of the questions listed on page 337. Then divide the group into five or six teams. Tell the kids that they'll have a certain amount of time to answer as many of the questions as they can. For example, the deadline for answering questions might be two weeks from the day the contest begins. To find their answers, the kids will have to do some research—and for some questions they may have to "dig" for the information they need. That could mean looking up information not only in encyclopedias, but also in other reference books and maybe even periodicals. (You can either give the kids some research time every day or so or let them work completely on their own time.)

Each team member can work on all of the questions, or else each person can be responsible for answering only one or two of the questions. (You might want to leave it up to each team to decide how to divide the workload.) Tell the kids that they don't have to find answers to all of the questions. But they won't receive points for unanswered questions or for questions answered incorrectly.

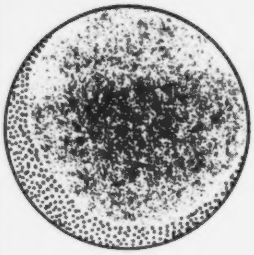
Have the kids write down the sources of their answers. (Even if they think they know an answer without having to look it up, they should try to find a source that backs up the answer.) Explain that, whenever they research something, it's important to keep records of their sources of information. That way they can easily find the information again if they need to refer back to it.

On the day of the deadline, have all of the teams neatly write their answers and reference sources on a piece of paper and hand them in. Then check their answers aqainst the answers we provide. Score a point for each correct answer and 0 points for each unanswered question or wrong answer. (Keep in mind that some of the kids' answers may be a little different from ours for a couple of reasons. First, the kids may have to rely on older sources of information that have become outdated by newer research and findings. Second, some of our answers—especially those involving numbers—are approximate, since exact answers aren't known and vary slightly from one source to the next. As long as the kids did their research they should probably get credit for an answer, even if it's different from ours.)

When you're finished checking the answers, go through all the questions with the kids. Then reveal the winning team!



DESERT QUEST



1. What makes the skin of some Tuareg nomads turn blue?
2. Name four ways some desert people use camels.
3. What percentage of the earth's surface is desert?
4. What are gibbers and where are they found?
5. What important liquid energy source is found under many desert areas?
6. Many scientists think that certain kinds of desert plants are among the oldest living things in the world. Name one of these plants.
7. About how tall can a saguaro (sah-WAH-ro) cactus get to be?
8. What is a tagilmust?
9. What do Bushmen store in ostrich egg-shells?
10. Why is oil sprayed on sand dunes in some deserts?
11. What well-known ancient culture thrived in a huge African oasis?
12. Where does a lot of water that irrigates California's Imperial Valley come from?
13. What continent has the largest desert and what is the desert's name?
14. What is a seif and what does the word *seif* mean?
15. The fruit of what cactus is a favorite of the Papago Indians?
16. What animal sometimes helps Australian Aborigines when they go hunting?
17. On which continent do scientists think the first camel evolved?
18. What valley represents the world's largest oasis?
19. Which desert-dwelling Native Americans are now known as the "ancient ones"?
20. Which large, stony desert did Genghis Khan and his troops ride through on their way to conquering China?
21. About how much water per person per day should you take with you on a trip into the desert?
22. What does the Mongolian word *gobi* mean?
23. How did the Joshua tree get its name?
24. What desert insects become very destructive when they gather in groups to swarm?
25. How can the oil of the desert plant called jojoba (ho-HO-ba) benefit the sperm whale?
26. Why do certain beetles in the Namib Desert often stand at the crest of a dune with their abdomens pointing up into the air?
27. What do the desert birds known as sandgrouse have in common with a sponge?
28. What is Pueblo Bonito and where is it located?
29. What substance do camels frequently carry to market in blocks?
30. What's a kuipad?

DESERT QUEST ANSWERS

1. the dye in their clothing
2. Camels can be ridden, they can carry goods to market, they provide meat and milk, their skins can be used to make saddles and shoes, their hair can be woven into cloth, the fat in their humps can be melted down and used as a cooking oil, and their dung can be used as a fuel
3. about 15%
4. Gibbers are red stones that cover parts of some deserts in Australia.
5. oil
6. bristlecone pine, creosote bush
7. About 50 feet (15 meters) tall. The average saguaro is around 30-40 feet (9-12 meters) tall.
8. the veil that Tuareg men wear
9. water
10. Oil stabilized dunes so that vegetation can take root
11. the Egyptians
12. the Colorado River
13. Africa—the Sahara Desert
14. A seif is a type of sand dune named for its razor-thin edge. *Seif* is the Arab word for sword.
15. the Saguaro
16. the dingo, a type of wild dog
17. North America
18. the Nile Valley
19. the Anasazi
20. the Gobi
21. a gallon (3.81)
22. pebbly plain
23. Mormon pioneers named this plant after the Biblical leader, Joshua. To them, the plant resembled Joshua pointing the way to the Promised Land.
24. desert locusts
25. Jojoba oil is very similar to sperm whale oil and can be used in place of it as a lubricant.
26. It's their way of getting water: The fog that condenses on their upraised bodies trickles down to their mouths.
27. A male sandgrouse's breast feathers are like a sponge in the sense that they can hold a lot of water. After soaking his breast feathers, a male flies back to his young and lets them drink the water he's brought.
28. It's a pueblo ruin in Chaco Canyon, New Mexico.
29. salt
30. the traditional long stick, made of saguaro ribs, that the Papago Indians use for harvesting saguaro fruit

VALUES AND ATTITUDES

20.

Many educators feel that the way to help students build a values system is to use a values clarification process throughout their schooling. The goal of this approach is to help students make choices about what they believe, weigh the pros and cons, evaluate consequences, accept that others have different beliefs, feel comfortable with the decisions they make, be willing to stand up for their beliefs, and take the final step to act on their beliefs. What's the role of the educator in this process? Mainly it's as facilitator—listening and questioning—to help students figure out their own feelings. For example, Louise Rath, in his book *Values and Teaching* (Merrill Publishing Co., 1978) outlines these three major steps in the values clarification process and what types of questions you can ask to help guide student thinking.

> ***Every human has a fundamental right to an environment of quality that permits a life of dignity, and well-being.***
>
> —UN Conference on the Human Environment, 1972

STEPS IN THE PROCESS OF VALUING	**KEY QUESTIONS TO ASK**
CHOOSING	Did you consider any alternatives? Have you thought about possible consequences? Was this something you yourself chose to do?
PRIZING	Is this something you really feel good about? Who have you told about this?
ACTING	What have you done about this so far? What will come next?

There are many creative and practical strategies that can help students begin to develop a values system, from activities dealing with awareness to those focusing on moral reasoning. In this section, we've included four activities that focus on values, attitudes, and moral reasoning. The first looks at the pros and cons of making a rare bird egg collection. The second activity focuses on reasons to protect the rain forests. The third activity looks at personal feelings and beliefs that involve reptiles and amphibians. And the final activity looks at attitudes about agricultural practices.

ACTIVITIES
IN THIS
SECTION

1. **RARE BIRD EGGS FOR SALE**, reprinted from *Project WILD* published by the Western Regional Environmental Education Council.
2. **WHAT WOULD YOU DO?** reprinted from *Ranger Rick's NatureScope: Let's Hear It for Herps!* published by the National Wildlife Federation (1988).
3. **AGRICULTURAL PRACTICES (A),** reprinted from *A Guide on Environmental Values Education* by Michael Caduto published by Unesco-UNEP International Environmental Education Programme, Environmental Education Series #13.
4. **AGRICULTURAL PRACTICES (B)**, reprinted from *A Guide on Environmental Values Education* by Michael Caduto. Published by Unesco-UNEP International Environmental Education Programme, Environmental Education Series #13.
5. **WHY SAVE THE RAIN FORESTS?** reprinted from *Ranger Rick's NatureScope: Rain Forests—Tropical Treasures* published by the National Wildlife Federation (1989).

RARE BIRD EGGS FOR SALE

OBJECTIVES:
Identify reasons for and consequences of collecting wildlife and wildlife products. Suggest and evaluate alternatives to collection to satisfy collection needs.

AGES:
Intermediate, advanced

SUBJECTS:
Language arts, social studies, science

MATERIALS:
Reference materials

People seem to collect everything—from rocks to stamps. Sometimes people collect wild and living creatures, both plants and animals. In some instances, these items are used for educational and research purposes. In other cases, as mementos of travel and memorable events. In other cases, they are acquired for their decorative and exotic values. In Victorian times, many homes were decorated with collections of stuffed birds, mounted butterflies, bird eggs, and bird nests. Whenever an object—living or not—is moved or removed from its natural environment, there is an effect on that environment, if not on the object or organism. Some of these effects are more obvious than others. Moving a rock under which wildlife lives may not seem as radical a move as taking eggs from a phoebe's nest or collecting dragonfly naiads from a pond or capturing and mounting 100 species of butterflies.

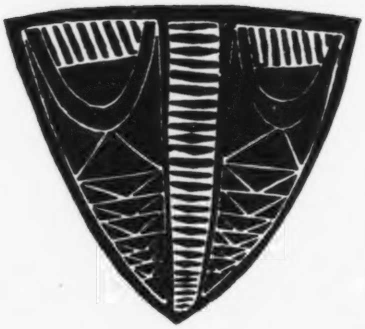
Managers of protected wilderness and wildlife areas often admonish visitors to "take only pictures and leave only footprints." Unfortunately, many people feel that this applies only to protected areas. Not necessarily so. For example, the effects can be substantial on species and the environment when 30 student collectors pick their way through an area in search of things to bring back to school. Collecting bird nests, as one example, can have several impacts—particularly in cases where the birds return to use the same nest year after year.

The major purpose of this activity is for students to examine the reasons for and consequences of people's collecting tendencies, as well as to consider alternatives.

Optional: Use this activity as an extension to a visit to a local natural history museum with taxonomic collections and dioramas.

PROCEDURE

1. Ask students to brainstorm all of the kinds of collections they have seen or heard of that involve living or once-living organisms, as well as any artifacts or rare objects made of living or once-living organisms. Examples could include butterflies, seashells, coral, bird eggs, ivory artifacts, pine cones, wild animals in zoos, animals in research laboratories.
2. Optional: Think of possible reasons for collecting. (Categorize the examples of collections according to what purposes they might serve. Some examples may fit into more than one category.) The idea is to think of a range of possible purposes—such as education, research, decoration, profit motive as in selling the collectibles, memories, pets, or status.



3. Ask the students to divide into two working groups: one to speak for the reasons that collecting of such things should be allowed, and one to speak for the reasons that collecting of such things should not be allowed. After dividing within each team to research aspects of the topic, each team should organize its information for presentation in a debate format. Each team can have a principal spokesperson or captain who makes opening, transition, and summary statements. That team captain can call on members of the team to provide specific information about pertinent topics as they arise during the debate. For example, a student on the "Reasons for Collecting" team might be an expert on the need for protecting genetic diversity by maintaining collections of wild animals in preserves and zoos. A student on the other team could be prepared to speak to the limitations of zoos and preserves that might outweigh the benefits. Both teams should consider consequences and alternatives, as well as include information about laws that already govern collecting, and areas where violations are serious problems. Note: The U.S. Fish and Wildlife Service is the agency in the United States that has legal responsibility for transportation of species between states and between the U.S. and other nations, as well as import and export of illegal wildlife and products. They can be contacted at: U.S. Fish and Wildlife Service, Department of the Interior, Washington, DC 20242. Contact state or province authorities for local regulations.

4. Following the debate, ask the students to discuss their feelings about the subject, based on the information and experience they now have. Was it difficult to debate "for" or "against" given their personal attitudes? Did students find their attitudes changing? If so, how? Ask the students to look again at their earlier list of possible purposes for collecting, adding any additional purposes they may have identified as a result of their research. Discuss and evaluate whether they think each purpose is appropriate or inappropriate. If appropriate, identify under what circumstances. Note: Consensus is not necessary, except in areas where law prohibits collecting.

5. Finally, ask the students if they can come up with a list of alternatives for people who might want to "collect" things that seem to the students to be inappropriate. For example, the butterfly collector might try photography, the bird nest collector might try model-building of nests using raw materials like birds do.

EXTENSIONS AND VARIATIONS

1. If combining this activity with a trip to a local museum of natural history, do steps 1 and 2 as part of pre-trip preparation; next go to the museum; and do steps 3, 4, and 5 after the trip.
2. After step 2 on the previous page, ask students to copy the list they generated—marking those items they feel they could accept as reasons to collect. Each student should keep his or her list until later. After the debate (in step 4), ask the students to look at their lists—reflecting the points of view they held before the debate. Are some purposes for collecting no longer acceptable that seemed so before, and vice versa?

EVALUATION

List three reasons why wildlife and wildlife products are collected by people. Identify and describe one situation in which you think that collection is inappropriate. Suggest and describe at least two alternatives a person might substitute.

Describe one way that collecting might contribute to the extinction of animal species. Describe one way that collecting might prevent a species from becoming extinct.

> *Every decision a person makes in [his/her] life is a personal, political, and spiritual decision . . you live your belief or you demonstrate that you do not have a belief.*
>
> —Anne Cameron

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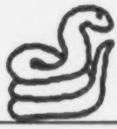


WHAT WOULD YOU DO?

OBJECTIVES:
Discuss some of the problems reptiles and amphibians face. Give examples of how personal feelings and beliefs can affect situations involving herps.

AGES:
Intermediate, advanced

SUBJECTS:
Language arts, social studies

MATERIALS:
Copies of the herp scenario, chalkboard or easel paper (optional)

In this discussion activity, your group can explore how they feel about a variety of issues involving reptiles and amphibians. Before starting, make copies of the herp scenarios on the following pages. Also make sure that everyone is familiar with the characteristics of reptiles and amphibians and with the different types of herps that make up each group.

Begin the activity by passing out copies of the scenarios to each person. Explain that they will be reading about a variety of situations that deal with reptiles and amphibians, and that they will have to decide what they would do if faced with the situation described. Emphasize that there are no "right" or "wrong" answers in the activity. The purpose is to learn about certain issues involving herps, to explore how they feel about the issues, and to discuss their feelings and opinions with others to get different perspectives.

Have each person read the scenarios and decide how he or she would deal with each situation, picking the option or options that most closely match how he or she would react. If none of the options apply, tell the kids to think about other actions they would take.

After the kids have had time to think about each situation, have them share their reactions. (You might want to keep a tally on a chalkboard or large piece of easel paper.) Encourage discussion and provide time for each person to discuss why he or she responded in a certain way. Ask the kids what kinds of things they kept in mind as they made their decisions. For example, did they choose what they thought were the most responsible actions to take? Did they think about laws that might affect the situation? Did they need more information before they felt comfortable making a decision? Afterward ask if the group discussion helped provide new perspectives or if, after listening to other people's opinions, any of the group members had changed their mind about what they might do.

As you discuss the scenarios, you might want to bring up some of the points listed on page 345. You might also want to try this option:

ANOTHER OPTION

Depending on the make-up of your group, you might want to try this activity using small discussion groups. Have one person in each group read a scenario to the other group members and tally how each person would react to the scenario. Encourage the groups to discuss their answers.

After about five minutes, have the groups move on to another scenario, and have another person in each group act as the reader and tally person. After all the groups have finished discussing each scenario, talk about each one with the entire group.

Herp Pets

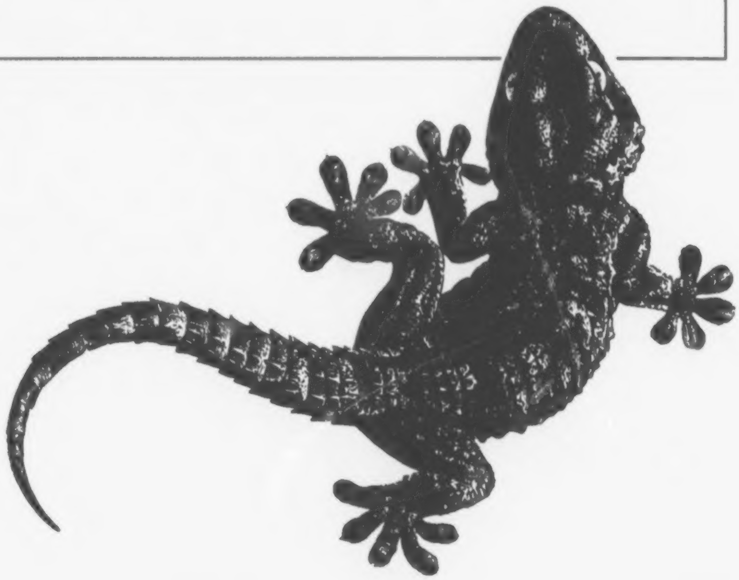
- Herp pets need a lot of care. For example, they need clean water, clean cages, the right temperature and amount of humidity, and a balanced diet. Many won't eat in captivity and some require hard-to-get food. Herps also get a variety of diseases in captivity.
- Many herps, such as turtles, carry diseases that can be transmitted to people. Some herps can also bite, and some are poisonous.
- It is very difficult to raise most reptiles from eggs, unless you have special equipment to control temperature and humidity.
- Many scientists do not recommend touching herp eggs because it can harm the developing embryos. For example, just handling some amphibian eggs can kill them because the protective jelly gets damaged.
- Buying non-native pets or collecting them in the wild and bringing them home with you can create a variety of problems. For one thing, it's often hard to supply them with the foods they normally eat. And it's also a problem if they escape into the wild. Introduced species have no natural predators, and if released, they can compete with—and often harm—native species.
- Many herp pets are very expensive.
- Many herp pets are sold illegally. And many herps that are collected illegally for the pet trade die before they are even sold.

Herp Laws

- It is illegal to collect animals from national parks and wildlife refuges as well as from most state and local parks.
- Federally listed threatened and endangered reptiles and amphibians are protected by the Endangered Species Act. It's against the law to buy, sell, possess, or abuse them in any way. There are also international trading laws that protect rare, threatened, and endangered species.
- It is sometimes impossible to tell if a product is made from an endangered or threatened species. For example, people who sell illegal wildlife products will often tell you their products are from captive-bred species. Conservationists say the best bet is not to buy anything you think could have come from a protected animal.

Other Herp Tips

- If you see a poisonous snake, herpetologists recommend that you back away quietly and don't try to confront it. Many people are bitten when they try to kill a snake.
- Most snakes are not poisonous. (Less than 10% of all snakes have venom that's capable of harming people.)
- Snakes are very important rodent-controllers. Many feed on rats, mice, and other pests.



WHAT WOULD YOU DO?

1

You best friend is about to go on vacation to a park in Texas. She's been reading about lizards of the West and tells you she's going to try to catch a horned "toad" while she's there. She tells you all about the habits of these lizards, such as what they eat, where they live, and how they defend themselves. She also explains how she's going to take care of it when she gets it home, showing you the book she checked out from the library on how to care for lizards.

What would you do?

- encourage her to bring the lizard back so you can learn more about it too
- tell her that you don't think it's right to take an animal out of the wild to keep as a pet
- read more about the lizard so you can help her take care of it
- ask her to bring you one, if she finds two
- tell her it's illegal to collect any living things in a park, but let her make up her own mind
- other

2

Bali and his sister find some leathery, white eggs buried in the leaves under a log. Bali thinks they might be snake eggs, but he's not sure. He's always wanted to have a pet snake, but the only pet he's ever had was a turtle.

What should Bali do?

- collect the eggs and put them in a terrarium when he gets home
- leave the eggs where they are, but mark the spot so he can return to check on them often
- collect one of the eggs and take it home to try to hatch it
- collect the eggs and take them to the nature center near his house
- other

3

You are on a hike with your friends and older sister when your sister spots a timber rattlesnake. The snake is close to the trail, sunning itself on a rock. Your sister tells everyone to stay perfectly still, then she picks up a large stick, slowly makes her way to the snake. and kills it.

What Do You Think?

- your sister was right to kill the snake because it was poisonous
- your sister shouldn't have killed the snake because the snake was sunning itself; but if the snake looked as if it might strike she would have been right to kill it
- all of you should have tried to walk away without harming the snake
- your sister was right to kill the snake because it's OK to kill any snake if it gets too close to people
- other

4

You and your family visit a roadside zoo that advertised an exhibit featuring live snakes and other herps. After paying $3.00 a person to get inside, you see that the exhibits are falling apart and the reptiles are poorly cared for. Many of the animals have no water, and others are crammed together in tiny cages. In one of the cages, a dead snake is in the corner. And the turtle tank is filthy.

What Would You Do?

- ask to see the owner and explain how upset you are about the conditions
- not say anything because you don't want to make the people that are working there feel bad
- ask for your money back and leave
- think about it and eventually call or write a letter to an animal protection organization
- not say anything because the people who run the zoo know more about taking care of herps than you do
- other

5 While on vacation in a foreign country, your mother decides to buy a pair of sunglasses with tortoise-shell frames. You remember reading that many sea turtles are endangered. But you're not sure that these frames were made from an endangered turtle.

WHAT WOULD YOU DO?

- ask your mother not to buy the glasses, just in case
- ask your mother not to buy the glasses, because you don't think it's right to make glasses from turtles whether they're endangered or not
- ask the salesperson if the frames are made from an endangered turtle, and if he or she says no, tell your mother it's OK
- let your mother decide for herself what she should do
- other

6 Every year, thousands of garter snakes hibernate in caves in Manitoba's lake region in Canada. In spring, as the garter snakes emerge, collectors from all over North America stand outside the dens, waiting to capture them. The collectors sell the snakes to supply companies and pet stores. Over the years, the number of dens has decreased from 100 to about 30 and scientists are worried that the snake populations are in trouble.

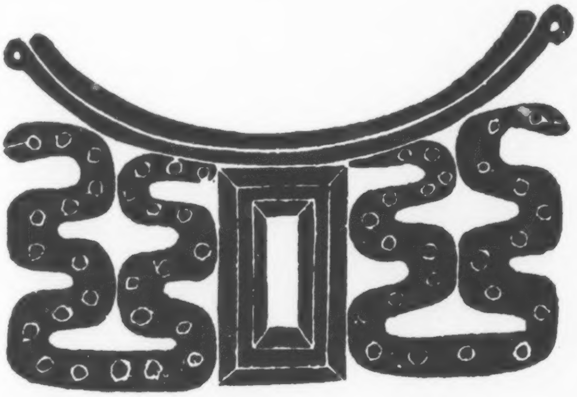
WHAT DO YOU THINK?

- it's OK to collect the snakes because many are being used in schools to educate people
- it's OK to collect some snakes, but the number of snakes collected should be regulated
- there should be laws to prohibit all snake collecting for profit
- other

7 Your next door neighbor takes a trip to India and brings back presents for your family. She gives you a belt made from the skin of an Indian snake.

WHAT WOULD YOU DO?

- thank her but tell her you can't accept the gift because you think the belt could have been made from an endangered snake
- thank her and take the belt, even though it might have been made from an endangered snake; later talk to her about products made from endangered animals so she's not likely to buy such a thing in the future
- get angry with her for buying a product made with snakeskin, and tell her she shouldn't have bought something if it even had a chance of coming from an endangered animal
- thank her and wear the belt because you'd be the only person with such a neat belt
- other



AGRICULTURAL PRACTICES (A)

OBJECTIVE:
Discuss the Green Revolution as a catalyst for fostering a better understanding of the state of food production and distribution today, and the impact of agricultural practices on the total human environment

AGES:
Intermediate, advanced

SUBJECTS:
Social studies

MATERIALS:
Copies of the worksheet "I'd Prefer to Live in a Country Where . . ."

In the 1950s, agricultural experts from around the world began the Green Revolution. By sending technical help to the farmers of developing, overpopulated countries, the experts hoped to assist the farmers in growing more and better food crops. Geneticists developed climate-adjusted strains of wheat, corn, and rice that would yield large amounts of nutritious grain. Engineers built tractors and harvesting machines that could cut labor and save grain. Chemists made fertilizers that turned poor farmland into good cropland. Irrigation systems were installed to expand growing space in desert countries.

Between 1950 and 1970, wheat production rose from 270,000 metric tons per year to 2.53 million. Corn production increased 250 percent. India alone increased grain production 2.8 percent a year, while the population of that country increased 2.1 percent a year.*

But all is not rosy in the Green Revolution. In another country of the Asian region, food-producing acreage jumped from 50,000 to 32 million acres in less than ten years. To work that much land requires a huge investment in machinery. The machines are made abroad, and the country practicing the Green Revolution has become totally dependent on foreign countries for tractors as well as for harvesting and milling equipment. Machines take the place of people. The farm-labor force in certain agricultural regions has dropped 50 percent in the 1970s, and in Latin America 2.5 million farm workers lost their jobs in just one year.**

The seeds, machines, and fertilizers are not given to the developing countries free of charge. The Green Revolution puts a great strain on the economies of these countries.

Are they spending their limited resources in the best way? Place a check mark in each of the cases on page 350. The class will discuss these statements afterward.

FOR DISCUSSION

Ask students to decide for themselves if their responses put them in the group favoring the continuation of the Green Revolution or in the group opposing the continuation of the revolution. (Responses 1b, 2b, 4b, 5b, 6b, 7a, and 8a are generally in line with support for the Green Revolution.)

Now ask those in favor of the revolution to propose a solution to this situation: the Green Revolution is machine intensive, not labor intensive. Most developing nations have an abundance of workers but little capital to spend on machines. Because of the high cost of oil, nearly every country "revolutionized" by the Green Revolution is today importing food.

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*Biology by Helen Curtis (Worth Pub., Inc., p. 968, 1979)

**"The Profits of Hunger" by Richard Barnet (*The Nation*, February 9, 1980, p. 129)

Ask those opposed to the Green Revolution to propose a solution to this situation: of the world's 4.5 billion people, at least 1 billion, that is 22 percent, are inadequately nourished. About one-third of the deaths that occur throughout the world are due to the effects of malnutrition.

(Note: This activity was developed in the 1970s. Students could also conduct research to find out what the situation is like today and how agricultural practices have changed in the past 20 years.)

AGRICULTURAL PRACTICES (A)

I'D PREFER TO LIVE IN A COUNTRY WHERE . . .

Are they spending their limited resources in the best way? Place a check mark next to the option that suits you best in each of the following cases. The class will discuss these statements afterward.

A.	B.
1. ☐ everyone who wants to can work at producing the food the nation needs.	1. ☐ farm workers are replaced by machines that could help produce abundant food.
2. ☐ food is limited to whatever the natural soil conditions will allow.	2. ☐ food is abundant because of the heavy use of commercial fertilizers.
3. ☐ the government urges farmers to grow food crops for use within the country even though that means there will be fewer nonfood crops for export.	3. ☐ the government urges farmers to grow nonfood items such as coffee or tea for export, even though that means less food will be grown for local consumption.
4. ☐ the food is raised by farmers using traditional equipment and methods even though that means a small yield and less variety.	4. ☐ the food is raised on large farms using advanced equipment that must be purchased from more highly industrialized nations.
5. ☐ food is limited to types the people are familiar with and know how to store and prepare even though the food is less nutritious.	5. ☐ new varieties of nutritious food are introduced even though the people don't like the food but are forced to use it or go without.
6. ☐ food is grown locally and limited to what can be distributed by traditional means even though some people in remote regions may go without food at times.	6. ☐ the limited government money is spent on building roads and bridges to the farthest regions of the country even though that means using up agricultural land to build roads and shifting money away from agriculture.
7. ☐ food is limited to a few highly nutritious types even though the limited variety puts a strain on the soil ecology (by always using the same minerals).	7. ☐ a wide variety of food is grown even though that means that some nutritious types (wheat) must compete for space with low-nutrition foods (sugar).
8. ☐ food is grown in abundance even though the farmers must rely on heavy applications of pesticides.	8. ☐ food is limited to types adapted to the insects, worms, bacteria, and viruses that are normally found in that country.
9. ☐ food is abundant due to strict government control of family size.	9. ☐ food is limited, but the people are free to have large families if they want them.

AGRICULTURAL PRACTICES (B)

OBJECTIVE:
Discuss the pros and cons of using chemical fertilizers vs. natural fertilizers.

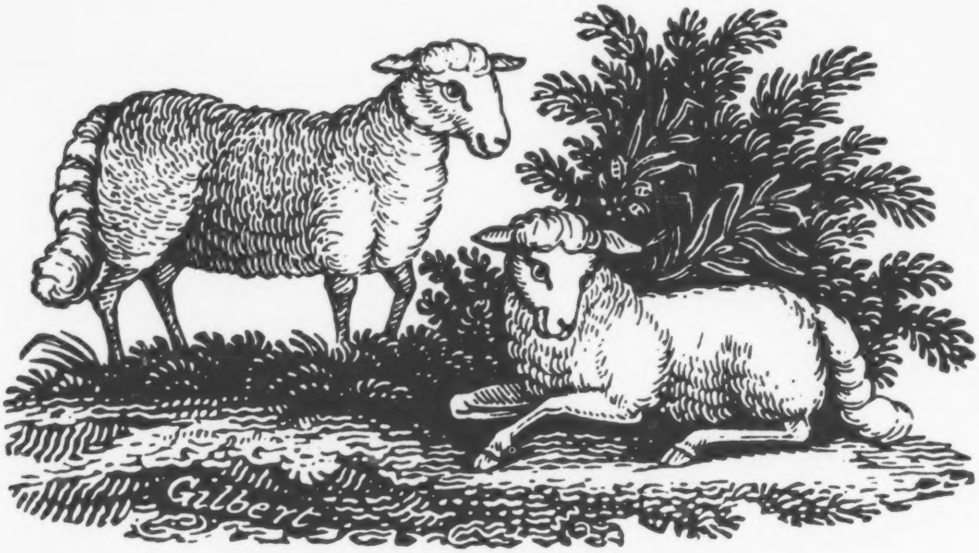
AGES:
Intermediate, advanced

SUBJECTS:
Social studies

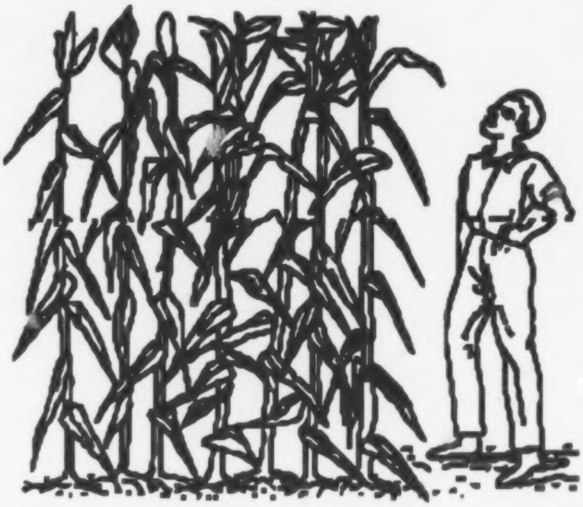
MATERIALS:
Copies of page 352

In small groups, distribute copies of the handout on page 352. Have students answer the questions posed. Afterward, in small groups or as a class, discuss the following:

- Based on the experience and knowledge of advanced agricultural sciences and technology, what information might a team of agricultural experts be able to offer the Zimbabwe farmers regarding the use of chemical fertilizers?
- What are some of the environmental impacts of both natural and chemical fertilizers? Which are the more damaging to the environment?
- When can the trade-offs between efficiency and environmental effects of factory-made fertilizers be considered significant?
- How do these issues apply to your own homes? What do your findings say about the use of fertilizers on your gardens at home? On your lawns? Is it wise to use chemical fertilizers to keep your lawn green?



AGRICULTURAL PRACTICES (B)

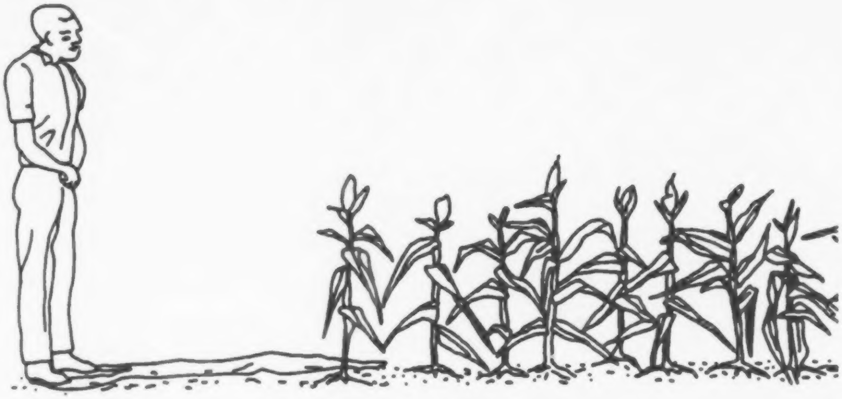


Mr. Moyo and Mr. Gumisa are farmers at Guto in Zimbabwe. Their farms are side by side.

Mr. Moyo is complaining to his friend about his maize plants. They have not grown as well as Mr. Gumisa's maize plants. Yet, rainfall was the same. It is not as though the weather conditions on the two farms were different.

Mr. Moyo says he ploughed his land just as did Mr. Gumisa.

Mr. Moyo says he decided to use only natural fertilizer on his land. He collected all the cattle manure from their kraal and mixed it with soil from an anthill and compost from his compost heap. "It was hard work, too," says Mr. Moyo. Mr. Gumisa knows that was a good idea, for indeed, natural fertilizer is very good for soil. He wonders, though, if Mr. Moyo had enough natural fertilizer for his five hectares of maize. He knows that if one uses natural fertilizer then a great deal is needed.



The two farmers each have five cattle. Mr. Gumisa used the manure from his cattle and compost for fertilizing his wife's vegetables and the groundnuts she was growing. For his five hectares of maize he bought synthetic fertilizer.

Finally, Mr. Gumisa decided he must invite Mr. Moyo, whom he liked so much, to his home and give him some beer. He would then try to explain to him why buying factory-made fertilizer has many advantages.

What did Mr. Gumisa say to his friend?

What was Mr. Moyo's response?

WHY SAVE RAIN FORESTS?

Experts say we're now losing more than 40,000 square miles of tropical rain forests every year, an area about the size of Pennsylvania. And if the present rate continues, there will be almost no tropical rain forests within about 65 years. This gloomy prediction doesn't even take into account increased pressures from growing populations, which could cause the destruction to speed up dramatically.

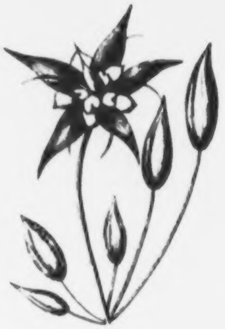
So what does the loss of thousands of acres of the world's rain forests really mean? In this activity, your group can discuss some of the worldwide consequences of rain forest destruction and why people feel the rain forests of the world need to be protected. Before doing this activity, you may want to do several of the activities in chapters 1, 2, and 3 in the rain forest issue of *NatureScope* so that your group has a good feel for what tropical rain forests are and what resources and peoples are found there. Then, after you complete this activity, you might want to see "You Can Help!" on page 52 in *NatureScope: Rain Forests—Tropical Treasures* for some ideas about what your kids can do to help protect tropical rain forests around the world.

OBJECTIVE:
Describe several reasons why it's important to protect tropical rain forests.

AGES:
Intermediate, advanced

SUBJECTS:
Science, social studies

MATERIALS:
Copies of page 355.



DEFORESTATION CONSEQUENCES

First divide the group into teams of four or five children. Have each team come up with a list of reasons why they think the rain forests of the world should be protected. Encourage them to come up with as many reasons as they can. (Also explain that there are many opinions about why we should protect rain forests. However, there are differences of opinion about what's the most important reason to save these tropical treasures.)

After the kids have had about 10 minutes to discuss the question, have each team appoint a spokesperson to report on what each team came up with. As each spokesperson presents the team's idea, make a master list of reasons on a chalkboard or sheet of easel paper.

Now pass out copies of page 355. Explain that the page contains 10 reasons commonly given for why tropical rain forests should be saved. Ask the team members to compare the master list to the reasons included on page 355 and decide if they want to add anything to the list. You might want to discuss the subtle differences between some of the reasons people give for saving tropical rain forests. For example, some people feel that rain forests should be protected so that native people living in the rain forest are not forced to move and adapt to a new way of life. Other people feel that native people should be protected because they know so much about the plants and animals of the rain forest. According to this reason, native people and their cultural heritage should be protected so that people in developed countries can learn more about rain forest resources that can help the rest of the world.

WHAT'S MOST IMPORTANT TO YOU?

Destroying rain forest for economic gain is like burning a Renaissance painting to cook a meal.

—Edward O. Wilson

After discussing the reasons to save tropical rain forests, have each team get back together and rank the list of reasons in the following ways. (Have each team use the master list you made on the board.) First have the team try to come to some consensus about the two most important reasons to save tropical rain forests. (Each person can pick out one or two reasons and then defend why he or she chose those reasons. Then the team can try to reach a consensus or they can vote on the top two.) Have each team pick a spokesperson to share what the team members came up with and to emphasize the varying views in the group. (The purpose of the ranking is to encourage discussion. Explain to the kids that there is no most important "reason" for saving tropical forests; however, many people feel that some reasons are more urgent than others.)

Next discuss some of the reasons that rain forests are being destroyed. (lumbering tropical forests for valuable hardwoods, clearing tropical forests for cattle ranching, clearing land for cultivation, cutting trees for firewood, harvesting other rain forest products, and so on) Then ask the kids to look at the master list again and decide which reasons they think would best convince other people around the world-especially those people who do not know much about rain forests or who may not show much interest in helping to protect them—that saving the world's tropical rain forests is important. Are the reasons the same as what the kids individually thought were important? If not, how do they differ?

After your discussion, have each team prepare an exhibit for the local library about the effects of tropical rain forest destruction and why it is important to help conserve the world's tropical resources.

TEN REASONS TO SAVE TROPICAL RAIN FORESTS

1 Many scientists think that destroying tropical rain forests could drastically change world weather patterns.

2 Tropical rain forests contain more than 50 percent of all plant and animal species in the world. If the rain forests are destroyed, most of these plant and animal species will be lost forever. Scientists predict this loss of species diversity would have serious consequences for the health of the planet.

3 Scientists have studied only a small percentage of the plants and animals that live in tropical rain forests. Every day we are losing species that could potentially provide people with new products and medicines, such as gasoline substitutes and cancer cures.

4 Tropical rain forests are exotic and unique wild places where amazing and strange plants and animals live. They have long inspired artists, scientists, and others. Loss of these incredibly diverse forests would be a serious loss for people everywhere.

5 As rain forests disappear, so will the cultural traditions of many native peoples. These indigenous peoples have a right to live where and how they want.

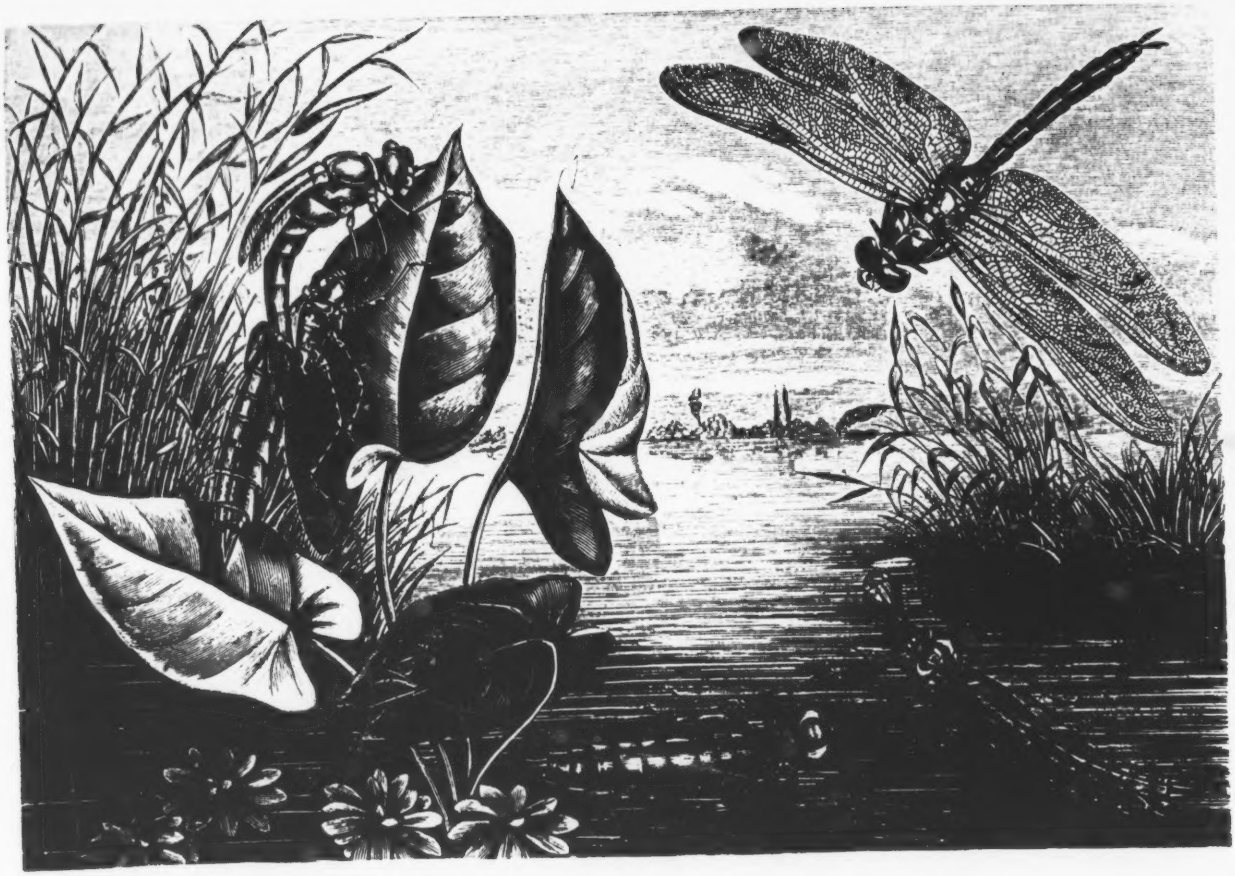
6 As native rain forest peoples die or are forced to move, the world will lose their knowledge of rain forest plants, animals, cycles, and other information that has taken hundreds of years to gather. This information about what's in the rain forest and how it "works" could help scientists develop new crops, farming techniques that don't harm the forest, and medicines and other products.

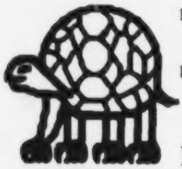
7 Many species around the world, including many North American songbirds that migrate to Latin America, depend on the tropics for survival. As more and more rain forest habitats disappear, the loss will affect species outside the tropics.

8 People who live outside of tropical rain forests depend on products from rain forests, including valuable hardwoods such as mahogany; bamboo; and foods such as bananas, nuts, and coffee. As the destruction continues, these products could become very scarce and more expensive.

9 The loss of thousands of acres of tropical rain forests is already causing serious local problems, including increased soil erosion and water pollution. As more deforestation occurs, the problems will increase.

10 People don't have the right to destroy the world's rain forests and other habitats for their own purposes.





Thinking About Thinking Skills

21.

> *We learn how to learn by learning; think by thinking. . . . There's no point in trying to think for our students.*
>
> —Richard Paul

Every time we make a purchase, we make an impact on the environment. In many cases, we don't think about why we choose a particular product—it might be the advertising, color, or package design that catches our eye. It might be an impulse purchase or loyalty to a brand name, or it might be the only product available. Many shoppers in all parts of the world often purchase products without consciously thinking about why they choose that particular product. But what if we did stop to evaluate the purchase by asking ourselves questions: Do I need this? How will I dispose of the packaging and leftovers? Will it harm my children or the environment? Is there a safer product? Is it cheap in the short run, but costly in the long run? And so on.

Critical thinking is "reasonable, reflective thinking that is focused on deciding what to believe or do." In other words, critical thinkers try to understand and be aware of their own biases, to be objective and logical, and to understand other points of view. Creative thinking is being able to come up with new ideas or possibilities—whether it relates to solving an environmental problem or takes the form of writing a short story.

Teaching students to develop critical thinking skills can help them make decisions in their own lives and help them tackle environmental problems. As mentioned earlier, it's important to teach thinking skills in context. For example, if you want students to practice the skill of detecting bias, don't just go through the steps of detecting bias. Present students with real articles that contain bias and have them learn how to detect it and avoid it in their own writing.

We've included three activities that focus on thinking skills: the first looks at detecting bias, the second focuses on transferring students' knowledge about watersheds to their local communities, and the third looks at evaluating the effects of different kinds of land use on wetland habitats.

Activities in this Section

1. **The Great Swamp Debate**, reprinted with permission from *Ranger Rick's NatureScope: Wading Into Wetlands* published by the National Wildlife Federation (1989).
2. **Go With the Flow**, reprinted with permission from *Ranger Rick's NatureScope: Pollution—Problems and Solutions* published by the National Wildlife Federation (1990).
3. **Dragonfly Pond**, reprinted with permission from *Aquatic Project WILD*, published by the Western Regional Environmental Education Council (1990).

THE GREAT SWAMP DEBATE

OBJECTIVES:
Discuss the differences between two newspaper articles dealing with the same subject. Define bias. Discuss the controversy that surrounded the proposal to build an airport in the Great Swamp in the early 1960s.

AGES:
Intermediate, advanced

SUBJECTS:
Science, social studies

MATERIALS:
Copies of the articles, pens or pencils, paper, chalkboard or easel paper.

Solving environmental problems isn't an easy job. In this activity your group will have a chance to see that, like all environmental issues, wetland issues can be very complex.

Before you start, copy the questions provided under "Analyzing the Articles" on a chalkboard or piece of easel paper. Then pass out copies of the articles. Explain that the two articles on the page represent a real environmental controversy. The controversy began in 1959 when a transportation agency for New York and New Jersey, called the Port Authority, came up with a proposal to build a huge airport.

Tell the kids they'll find out later how the controversy was resolved. But first they'll be finding out more about it by reading the two articles you passed out and by answering some questions about them. Tell the kids that the articles aren't real, and neither are the quotes or names given in them. But the circumstances we've presented concerning the proposed airport, along with the controversy it raised, are true.

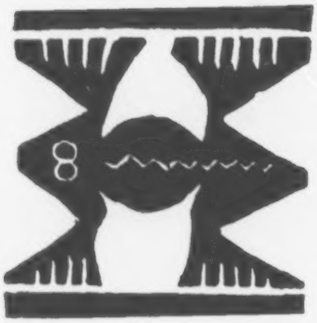
When everyone has finished reading the articles, tell the kids to draw a line down the middle of a blank sheet of paper. Have them write "Article 1" at the top of one column and "Article 2" at the top of the other. Then give them time to answer the questions you wrote down. Explain that they'll be answering questions two, three, and four for both Article 1 and Article 2. (Questions one and five are a little different. Have the kids answer these questions on the other side of their sheets.)

While you're going over the answers, discuss why it can be difficult for people to find out all the facts about an issue. One reason for this is that the news sometimes presents information in a biased way. Ask the kids if they know what the word biased means, then ask if they think either of the articles is biased. (Both are. Article 1 doesn't present any of the disadvantages of building the airport in the Great Swamp, and Article 2 doesn't present any of the advantages. That's not to say that the information presented in either of the articles is necessarily wrong—it's just incomplete.) But even though it may be difficult to know all of the facts, people still must make decisions—decisions that often affect people, wildlife, and other natural resources. That's why it's important to try to find the least biased information available and to carefully consider all of the alternatives.

Now tell the kids what finally happened in the airport/Great Swamp controversy. Here's a synopsis:

The airport was never built. Instead, three nearby airports—Kennedy, LaGuardia, and Newark—were remodeled and/or expanded. The increased air travel that the Port Authority claimed would occur turned out to be not as dramatic as the figures predicted.

The Great Swamp Committee managed to raise enough money to buy the Great Swamp, and they donated it to the United States Government in 1964. It was established as a National Wildlife Refuge, National Natural Landmark, and Wilderness Area, which permanently protected it from development. Today it serves not only as a sanctuary for wildlife but also as a recreation area for bird watchers, hikers, nature photographers, and others. And biologists and other researchers use the Great Swamp as an outdoor "lab."



ANALYZING THE ARTICLES

1. After reading the two articles, which of the following would you say is the main problem that needs to be solved?
   a. whether to build the airport in New York or in New Jersey
   b. whether or not the airport should be built in the Great Swamp
   c. how big the airport should be
   d. how far the airport should be from New York City
2. Does the article discuss any advantages of building the airport on the chosen site? If so, list them.
3. Does the article discuss any disadvantages of building the airport on the chosen site? If so, list them.
4. Which of the following attitudes does the article seem to have toward swamps?
   a. swamps are valuable in their natural state
   b. swamps aren't worth much in their natural state
5. Can you think of any compromises or alternatives to the issue of whether or not an airport should be built on the proposed site?

ANSWERS

1. b
2. Article #1—yes (would make a "useless swamp" useful to people; could help businesses grow, which would increase economic growth for Morris County; would create jobs); Article #2—no
3. Article #1—no; Article #2—yes (would be difficult and costly to develop the swamp; would increase pollution and noise levels; existing roads might not be able to handle the additional traffic; schools, houses, and other buildings might have to be destroyed; plants and animals would lose their habitat; the water supply in the area might suffer)
4. Article #1—b; Article #2—a
5. Other airports could be remodeled or enlarged; another site might be less costly and less environmentally damaging to develop; and so on.

New Airport Needed in Jersey

New York—The Port Authority, a transportation agency for New York and New Jersey held a meeting here yesterday. The purpose of the meeting was to discuss plans for a new major airport to be built in the New York-New Jersey area. Ed Warren, a speaker for the Port Authority, explained that the airport will satisfy the growing need for more air travel services in the region.

The airport would need a large, level site, and one that's fairly close to New York City. "We've studied fifteen possible sites," said Warren, "and we think we've found the perfect location." Warren reported that the preferred site is in Morris County, New Jersey. "It's nothing but a big swamp right now, but it will be very useful to a lot of people once the airport gets underway."

Port Authority figures show that the other major airports in the area will soon have more business than they can handle. In the next five years, business is expected to double. And in fifteen years, it could increase by as much as three to four times its current level.

Discount store owner John Landis commented on the favorable effects the airport would have on stores, restaurants, and hotels located near it. "Our business will increase—no doubt about it," he said. "And that means more economic growth for Morris County."

Labor leader Tom Hines agreed. "Thousands of new jobs will open up when building begins," he added. "There will be new opportunities for planners and construction workers. And once the airport opens there will be even more jobs. The airport will need ticket checkers, air traffic controllers, maintenance workers, and many, many others. Plus, the new airport will attract all kinds of new businesses around it."

GREAT SWAMP IN DANGER

MORRISTOWN, NEW JERSEY—Scientists, naturalists, and concerned citizens met here yesterday to discuss the plan for a new major airport to be built in the Great Swamp of Morris County. The purpose of the meeting was to discuss what can be done to prevent the building of the airport.

Sam Brown, a long-time resident of Morris County, presented facts from several scientific reports. "The reports indicate that building the airport in the Great Swamp will cause more problems than it will solve," he said. According to the reports, the swamp area would be very difficult and costly to develop. "It's going to cost a lot of money to drain out the swamp water and keep it out," Brown said.

Increased noise and pollution to communities near the swamp were cited as other problems that the airport would cause. Many people also feel that existing roads will not be able to handle the added traffic to and from New York.

Tina Shore, another Morris County resident, pointed out that many homes, churches, and schools near the proposed airport site would probably have to be destroyed to make way for the huge airport. "It would affect thousands of people," she said. "And it might affect the water supply in the area."

University biology professor Judy Dayton talked about the history and biology of the Great Swamp. "The swamp is left over from the last Ice Age, when the area was part of a glacial lake. It's home to many plants and animals," Dayton explained. "Building the airport here would destroy their special habitat. And many wouldn't be able to adapt to new surroundings."

"I grew up with the swamp as my playground," said Allen Jones, a local high school student. "The Great Swamp has a lot to teach us all," he added.

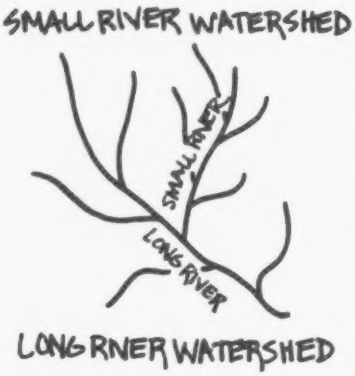
GO WITH THE FLOW

OBJECTIVES:
Define watershed. Explain how pollutants can affect water quality in a watershed.

AGES:
Intermediate

SUBJECTS:
Science, geography

MATERIALS:
Copies of page 365, markers or colored pencils, state highway, regional, or topographic maps, tracing paper, masking tape



No matter where you live, you live within a watershed. Conditions within that watershed greatly affect the quality of the rivers and streams flowing through it. After learning about watersheds, the kids in your group will have a better understanding of how water can become polluted. But before you do this activity, make sure the kids are familiar with some of the different kinds of water pollution. You might want to do "Guilty or Innocent?" on page 61 in the wetlands issue of *NatureScope* with the kids to introduce them to some forms of water pollution.

PART 1: UPSTREAM, DOWNSTREAM

Begin by asking the kids if they've ever seen splotches of oil in a parking lot or driveway. Then tell them that by doing this activity they'll find out what eventually happens to this oil.

Next introduce the group to the term watershed. Using the diagram in the margin, explain that a watershed is an area of land from which rainwater and snowmelt drain into a particular stream or river. Watersheds may be small areas of land that drain water into small streams or huge areas of land that drain water into large rivers. And within each large watershed there are many smaller watersheds. A watershed is usually named after the stream or river it drains into.

Point out that as rain and snowmelt flow across land and into waterways, they wash over everything in their path: golf courses, roads, fields, lawns, woodlands, and so on. And they pick up and carry material along the way: trash, dirt, pesticides, oil, and so on.

Next pass out copies of page 365 to the group. Tell the kids to use the map at the top of the page to answer the questions on the bottom of the sheet. (If the kids are having trouble determining the boundaries of the watershed, have them look at the streams on the map to see which way they flow. Those flowing into the Cedar River are in the Cedar River watershed. See diagram page 364.) Afterward go over the page with the kids, using the answers on page 364.

PART 2: LOCAL WATERS

Now have the kids map the watershed they live in. Pass out state highway, regional or topographic maps of your area that show a stream or river flowing through (or near) your community. (For topographic maps of your area contact the U.S. Geological Survey, Map Sales, Box 25286, Denver, CO 80225.) Also pass out sheets of tracing paper, masking tape, and colored pencils or markers and tell the kids to follow these directions:

1 Find your community and the nearest stream or river on the map. Then tape tracing paper over that section of the map. (Note: As we discussed in the answers to Part 1, slope is the factor that separates one watershed from another. Depending on the slope of the land in your area, the watershed or the nearest stream or river may or may not include your community. The only way to tell is to look at slope on a contour map. For this activity, the kids can assume that your community is in the watershed of the nearest stream.)

2 Use a colored pencil or marker to trace the stream or river downstream until it joins a larger river. Use the same colored pencil or marker to trace the stream upstream as far as you can and to trace all the tributaries that dump into the river or stream all along its length.

3 Use a different colored pencil or marker to trace other streams and rivers in your area.

4 Outline the watershed you live in. (Remind the kids that the watershed they live in is made up of all the land that drains into the nearest stream or river. So, to outline the watershed, they should be outlining the land surrounding the nearest waterway and all its tributaries.)

Afterward discuss the following questions as a group.

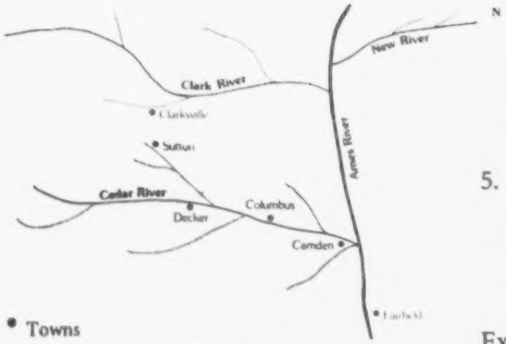
- What types of things do rainwater and snowmelt flow over in your area? (rooftops, sidewalks, roads, agricultural land, lawns, golf courses, and so on)
- What kinds of pollutants might rainwater or snowmelt pick up as they flow through your area? (Rainwater and snowmelt that run over streets, parking lots, fertilized yards, construction sites, and so on, often pick up toxic chemicals, silt, and other pollutants. The water then flows into storm drains that empty into rivers. And water running off agricultural land often contains high amounts of animal waste, pesticides, fertilizers, dirt, and other pollutants.)
- In what other ways might your community affect water quality? (some industries dump pollutants directly into rivers; pollutants from overflowing sewage treatment facilities may wash directly into waterways; pollutants from landfills or dumps may leak into water supplies; and so on)
- Which nearby communities might be affected if your community dumped untreated sewage into the nearest stream or river? (those downstream) Which communties could affect water quality in your community? (those upstream)

Finally, ask the kids what happens to the oil splotches you talked about in the beginning of the activity. (the oil may wash into your local stream or river and be carried downstream)

(*This activity was adapted from* Conserving America: Rivers Resource Guide. *published by the National Wildife Federation and WQED/Pittsburgh.)*

ANSWERS TO "GO WITH THE FLOW" ON PAGE 365:

1. See diagram.
2. Ames River watershed, Clark, and New
3. Columbus, Camden, and Fairfield because they are downstream from Decker
4. Cedar River, then into Ames River; Clark River, then into Ames River. Because Sutton is closest to the Cedar River and Clarksville is closest to the Clark River. However, they could be in the same watershed, depending on the slope of the land. For example, if a mountain or hill separated Clarksville from the nearby stream, wastewater from Clarksville could flow into the Cedar River watershed. It's more likely though that Sutton is part of the Cedar River watershed and Clarksville is part of the Clark River watershed. (Note: They are both in the same larger Ames River watershed.)
5. Many of the pollutants carried by the Ames and the two other rivers—pollutants that were collected from large areas of land—would end up in Lake Churchill; as pollutants accumulate in Lake Churchill, water quality could decrease significantly and aquatic plants and animals could be affected.



• Towns

Note: The Ames River flows north to south.

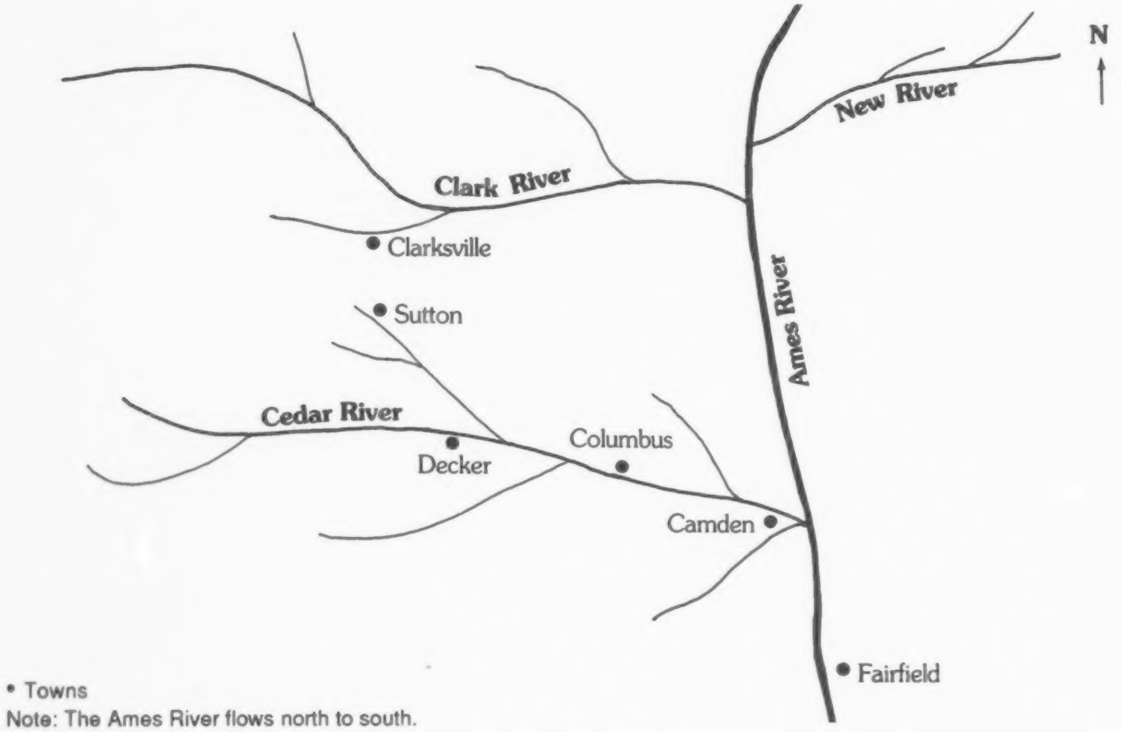
Explain that as rivers empty into bays, lakes, and other bodies of water, some of the waste they're carrying can accumulate in these areas. This accumulation can create big pollution problems. For example, the Chesapeake Bay and the Great Lakes are suffering from the accumulation of pollutants flowing into them.

ACTION TIP: HELP A LOCAL WATERWAY

Your group can organize a cleanup, set up a monitoring program, or organize a media campaign to make others in your community more aware of the problems facing a local waterway. Here are some organizations to contact for more information:

- Adopt-A-Stream Foundation, Executive Director, Box 5558 Everett, WA 98201. (Send a stamped, self-addressed, legal-size envelope.)
- Save Our Streams, Izaak Walton League 1401 Wilson Blvd., Level B, Arlington, VA 22209 .
- GREEN (Global Rivers Environmental Education Network), School of Natural Resources, The University of Michigan, Ann Arbor, MI 48109-1115.

GO WITH THE FLOW


N
New River
Clark River
Clarksville
Sutton
Ames River
Cedar River
Columbus
Decker
Camden
Fairfield
• Towns
Note: The Ames River flows north to south.

1. Find the Cedar River and all the Cedar's tributaries—the smaller streams and rivers that flow into it. Then outline the Cedar River watershed.

2. What larger watershed is the Cedar River watershed a part of? What other rivers are part of this watershed?

3. There's a chemical manufacturing plant in Decker that dumps its waste into the Cedar River. What communities might be affected by this waste? Explain your answer.

4. Which river or rivers would animal waste and other pollutants from farms near Sutton wash into? What about from farms near Clarksville? Why would you think that Sutton and Clarksville are in two different watersheds? Is it possible for Sutton and Clarksville to be in the same watershed? Explain your answer.

5. Eventually the Ames River empties into Lake Churchill. Two other large rivers also empty into Lake Churchill. What effect might these three rivers have on conditions in the lake?

378

DRAGONFLY POND

OBJECTIVES:
Evaluate the effects of different kinds of land use on wetland habitats; discuss and evaluate lifestyle changes to minimize damaging effects on wetlands.

AGES:
Primary, intermediate

SUBJECTS:
Science, social studies

MATERIALS:
For each 3 students: scissors, masking tape, paste or glue, paper, one set of land-use cutouts, one Dragonfly Pond cutout, a large piece of paper (18"x24") upon which to fasten the cutouts

Every human use of land affects wildlife habitat, positively or negatively. What humans do with land is a reflection of human priorities and lifestyles. The search for a modern day "good life" and all of its conveniences produces mixed results for wildlife and the natural environment. Sometimes people see undeveloped areas of natural environment as little more than raw material for human use. Others believe that the natural environment is to be preserved without regard for human needs. Still others yearn for a balance between economic growth and a healthy and vigorous natural environment. Very real differences of opinion regarding balance exist between well-meaning people.

At the core of land use issues is the concept of growth. Growth in natural systems has inherent limits, imposed by a dynamic balance of energy between all parts of the system. Energy in natural systems is translated into food, water, shelter, space, and continued survival. This means that the vitality of natural systems is expressed by their ability to be self-regulating. This capacity for self-regulation makes it possible for all natural members of an ecosystem to live in harmony. All the life forms of any ecosystem must be considered. The microbes in the soil are just as necessary to a habitat as the plants and predators. It is this natural dynamic balance, with all its inherent and essential parts, that much of human land use has tended to disturb. Human activities can often go beyond natural limits of a setting. Humans have the ability to import energy sources that allow a system to extend to its natural limits—or to remove energy sources that are necessary for a system to stay in balance. For example, people can build dams to create power, water can be captured for irrigation, wetlands can be drained for homes and buildings. All of these activities affect wildlife habitat.

Wetlands, for example, are often seen as swampy wastelands, yet they are the nurseries for hundreds of forms of wildlife. Fish, frogs, toads, migrating birds, snakes, insects, and a remarkable variety of plants all make a home of wetlands. Wetlands are highly vulnerable to development, pollution and a variety of forms of human interference with the natural flow of water. Hundreds of thousands of acres of valuable wetlands are lost each year—for example, to draining, dredging, filling, and pollution.

Given the extensive impact humans have already had and continue to have on the land, a major challenge now facing humans is how to have a more responsible impact. How can we develop the awareness, knowledge, skills, and commitment that are necessary in order for humans to take responsible actions affecting the remaining areas of natural wildlife habitat? How can we develop the necessary understanding to restore a more natural dynamic balance in places where human disturbance has existed for centuries?

The major purpose of this activity is to encourage students to wrestle with these concerns. In this simulation, students use the "Dragonfly Pond" as a microcosm of environmental concerns involved in management decisions. They struggle with the arrangement of overlapping and conflicting land uses in an effort to preserve a wetlands habitat. When the students reach some kind of agreement about the local issues, the activity shifts to how what they have done affects other dragonfly ponds downstream. The activity ends with consideration of the idea that the planet is, in fact, a single "Dragonfly Pond."

Procedure

1. Prepare copies of the cutout sheets ahead of time. Explain the activity. Tell the students that they will be responsible for arranging the pattern of land use around the Dragonfly Pond in such a way as to do the best they can to preserve the health of this beautiful aquatic area.

2. Divide the class into groups of three to five, with each group representing one of the interest groups. Students will stay in groups until the end of the activity. Possible interest groups are

- Residents: want to live in the area
- Farmers: want to use the land to raise food and livestock
- Business Interests: want to use the land for commerce and economic growth
- Gas Station Owners: want to make a living in servicing and repairing cars
- Parks Department Personnel: want people to have a place for recreation
- Highway Department Personnel: want to maintain access in the area
- Bleach Factory Representatives: want to preserve jobs and commerce

Note: Add others that you think may be locally important.

3. Pass out the land use materials. Pass out the large paper that will serve as the base for each group's pond and its associated land use activities. Have the students cut out the land-use pieces and the Dragonfly Pond. Tell them that all the land-use cutouts must be used. They can be cut smaller than they are, but all the parts must be used. They may touch, but they cannot overlap. The students may also create additional land uses of their choosing. When they fasten their cutouts to their large base sheet, suggest that they use small loops of tape. This will allow them to change their minds before they paste them down.

4. Once the students have cut out the necessary materials and are ready to begin the process of making land use decisions, have them first create a list of pros and cons for each land use. Guide the class discussion so that they consider the consequences of each land use.

Record these on the chalkboard. The following are only a few of the many possible examples:

	PRO	**CON**
FARMS:	produce food economic value provide jobs through seasonal employment	use pesticides (herbicides, insecticides) that may damage people and environment source of natural soil erosion sometimes drain wetlands for farm lands use chemical fertilizers that may damage water supplies
BUSINESSES:	produce employment provide commerce create economic stability	produce wastes and sewage may contaminate water (detergents, pesticides) use chemical fertilizers (lawns, etc.)
HOMES:	provide a sense of place develop a sense of community	generate wastes and sewage use water contribute to loss of wildlife habitat

5. Have the students work in their teams for a long enough period of time to begin to seriously grapple with the challenge.

6. Invite each group to volunteer to display and describe their work in progress. Encourage discussion of their choices. In the discussions emphasize that:

- no land use can be excluded
- wildlife habitat must be preserved
- everyone must agree

Look for the consequences of their proposed land use plan. Be firm about the issues, but fair about this being a very difficult set of choices. Ask additional groups to volunteer to show their work in progress, and discuss theirs similarly. *Note: For wildlife habitat this is a "no-win" activity in many ways. The best that can be hoped for is that the land use plans will minimize the threats to the Dragonfly Pond.*

7. Continue the discussion by asking more students to share their proposed plans. Again, be firm in discussing the consequences. Point out that shutting down the factory and businesses will be likely to destroy the economic base of Dragonfly Town. Abandoning the farm affects food supplies and employment. Farmlands provide habitat for

some wildlife. However, if wetlands are drained to create farm land, that results in a loss of habitat for some wildlife as well as a loss of other important values of wetlands.

8. Give the students additional time working in their groups to come up with what they believe to be the best possible land use plan, under the circumstances. Being sensitive to their frustrations, display all the final land use plans above a chalkboard for all to see and discuss. Analyze and discuss the merits of each of the approaches. Point out that although their solutions may not be perfect, they can minimize the damage to Dragonfly Pond.

9. Choose one of the students' images above the chalkboard. Next, on the chalkboard, continue Dragonfly Creek downstream. Many students tend to dump effluent below Dragonfly Pond and let it flow downstream. Show the route the stream might travel. On the chalkboard drawing, have the downstream part of Dragonfly Creek become another pond and wetland, and label the new area Laughing Gull Lake. Continue the drawing to Sea Oats Estuary and finally into Gray Whale Gulf.

10. Ask the students to brainstorm possible problems that could be faced within each of these aquatic systems as a result of the human activities at Dragonfly Pond. Make inferences and predictions about the potential consequences of these activities. For example, you could emphasize the effluent from the bleach factory. How will it be treated? Where? By whom? Where will it go? With what effects?

11. Ask the students to look again at all of the land uses in this activity. If they had been considering any of them as inherently bad, have them consider a different question. What could the people who are actually in charge of these various land uses do in their practices to minimize the damage to Dragonfly Pond? Have the activity end with an emphasis on "solutions" rather than on problems. Point out, for example, the revolution taking place in the "mining" of industrial effluents through "scrubbers" to extract wastes as profitable resources. (Perhaps the students need to make a "scrubbing filter" for the bleach factory.) Agricultural practices are changing so as to reduce the use of potentially lethal agents. Petroleum wastes are being recycled and domestic awareness regarding uses of pesticides and detergents is evolving.

12. Ask the students to create a list of things they think they personally can do to begin to reduce the potentially damaging effects of their own lifestyles on the "downstream" habitats they may never have thought about. If possible, invite them to periodically, throughout the school year, report on their progress in carrying out these new practices. Consider with them in discussion the idea that all the waters of the planet are, in fact, part of a single "Dragonfly Pond."'

EXTENSIONS

1 Set up an action team to locate a dragonfly pond in your community. Determine overall quality of the wetlands with which it is connected.

2. Trace any stream or river system that passes through your community from its source to its final entrance into the seas. List all the sites that you can identify that lower the quality of the waters in their journey and suggest how to reverse the process.

3. Collect newspaper articles for local water-related and land use issues as a current events activity.

4. Learn more about environmental impact statements. Try to obtain actual copies of statements about wetlands in your area. See what concerns are addressed in these documents.

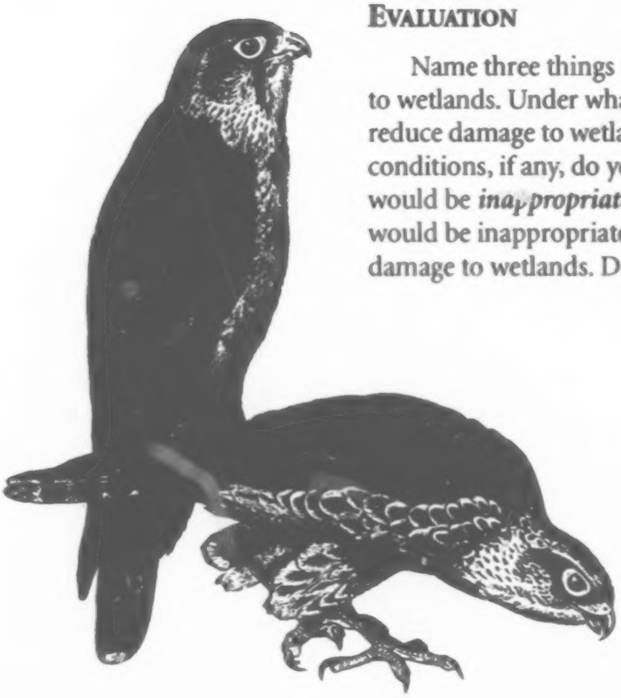
5. Learn about the national wildlife refuge system. Are there any wildlife refuges in your area? What animals find refuge in them? Visit a national wildlife refuge.

6. Find out about private organizations that work to protect wetlands. Two examples are The Nature Conservancy and Ducks Unlimited. Find out about what they do and how they do it.

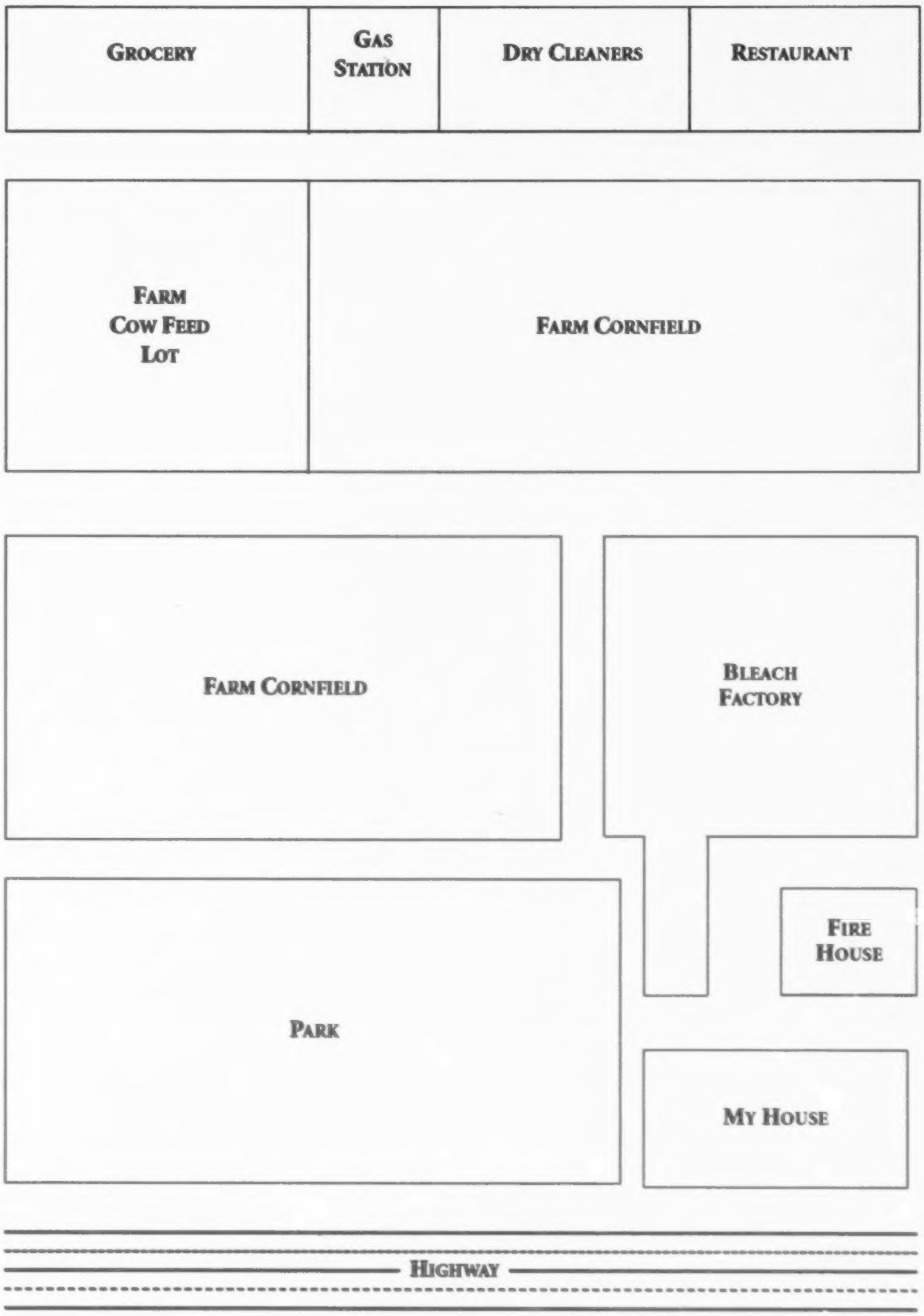
7. Find out about zoning laws and land use regulations in your area. Would the plan your group proposed for Dragonfly Pond be allowed in your community?

EVALUATION

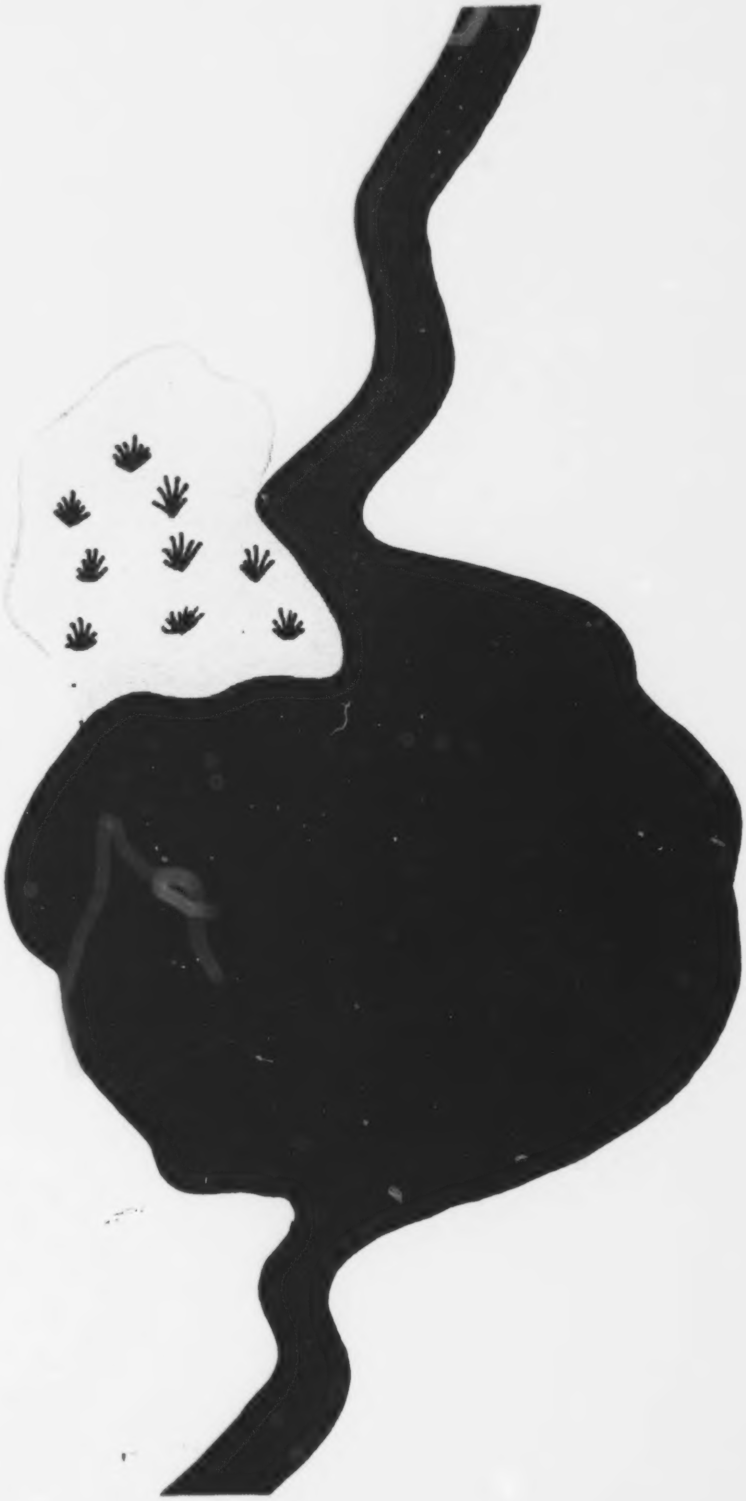
Name three things that people can do to reduce or prevent damage to wetlands. Under what conditions, if any, do you think actions to reduce damage to wetlands would be ***appropriate?*** Under what conditions, if any, do you think actions to reduce damage to wetlands would be ***inappropriate?*** Select any action that you personally think would be inappropriate and that you could take to reduce or prevent damage to wetlands. Describe what you would do.



DRAGONFLY POND


GROCERY
GAS STATION
DRY CLEANERS
RESTAURANT
FARM COW FEED LOT
FARM CORNFIELD
FARM CORNFIELD
BLEACH FACTORY
FIRE HOUSE
PARK
MY HOUSE
HIGHWAY

DRAGONFLY POND



COOPERATIVE LEARNING ACTIVITIES

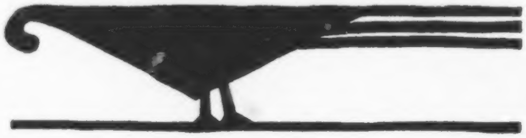
22.

> *In the forest, tree leans on tree; in a nation [people on people].*
>
> —Eastern European Proverb

Cooperative learning has a lot going for it, from motivating students to increasing students' self esteem (see Chapter 6). So how can you implement cooperative learning? There are dozens of strategies that can work and many resources that can help you determine what makes the most sense for your group. Many educators feel that dividing students into groups of 3-5 work best, with each person being assigned a sample role. For example, one student would be responsible for getting and taking care of any materials needed for the assignment, another student would make sure the group finishes on time, another would act as supervisor, another would write what happened in the group, and the last person might make an oral presentation to the rest of the class. We've listed some excellent resources in the Bibliography that explain how to make cooperative learning work and give examples of different types of cooperative activities.

In this section, we've included three sample activities to highlight cooperative learning. The first activity includes a variety of scenarios to promote thinking skills. Although each is written for students to do independently, you can easily adapt them to use as cooperative learning activities. For example, scenario #3, which focuses on pollination in the rain forest, can be used as a jigsaw. (A jigsaw is an activity where information is divided up into several pieces and each student is responsible for one piece and shares the information with others.) First, make 5-6 sets of clues, depending on how many teams you will be following. (There should be 4-6 students on a team.) Write each clue on a separate index card or piece of paper. (You can create more clues by separating each bit of information listed.) Give each member on a team 1-3 clues from the set. Then explain that they have to figure out which animal pollinates which plant by working together. The only rule is that they can't show their clues to any other team members.

The second activity focuses on using cooperative strategies to complete a research questionnaire. Although some of the information is out-of-date, the activity is a good model for cooperative learning and can be adapted by including more current information. The third activity encourages students to work together to rate products according to their environmental impact. Many of the other activities in this manual also promote cooperative learning.



ACTIVITIES IN THIS SECTION

1. **JUNGLE SLEUTHS**, reprinted with permission from *Ranger Rick's NatureScope: Rain Forests—Tropical Treasures* published by the National Wildlife Federation (1989).
2. **WE CAN ALL BE EXPERTS**, reprinted with permission from *Food First Curriculum* published by the Institute for Food and Development Policy.
3. **RATERS OF THE PLANET ECO** by Maura O'Conner. Reprinted from *Living Lightly on the Planet—Volume I,* Grades 7-9, used with permission through arrangement with Schlitz Audubon Center of the National Audubon Society, 1111 East Brown Deer Road, Milwaukee, WI 53217. All rights reserved.

JUNGLE SLEUTHS

Ants that farm fungus. Bees that "wear" perfume. Butterflies that fool predators by looking like other species. Tropical rain forests are full of these and other strange and amazing animals and plants. In this activity, the kids in your group will learn more about these unusual creatures and how they interact with other living things.

Begin by discussing tropical rain forests with the kids. You might want to do several of the activities in Chapter 1 of the rain forest issue of *NatureScope* to teach the kids where these forests grow and what they're like. You might also want to show the kids pictures of some tropical rain forests in different parts of the world.

Now pass out copies of the scenarios that follow to the kids. Explain that there are four different scenarios about tropical rain forest plants and animals. The kids should read each one and follow the directions that go along with it. For example, in one scenario they might have to answer questions and in another they might have to solve a problem.

When the kids have finished, go over each scenario, using the information under "What's Happening Here?"

OBJECTIVES:
Name several rain forest animals and describe how they depend on other species to survive.

AGES:
Intermediate, advanced

SUBJECT:
Science

MATERIALS:
Copies of the scenarios provided, pictures of tropical rain forest (optional)

ANSWERS TO SCENARIOS

SCENARIO 1

1) Since predators tend to avoid ithomiine butterflies, an edible butterfly that looks like an ithomiine would have a good chance of being avoided too.
2) If there are more edible look-alikes than true ithomiine butterflies living in a forest, it's more likely that the ithomiines would be hunted. That's because a predator would be more likely to have caught tasty butterflies than true ithomiines in the past, and would associate the coloration pattern with good taste instead of bad.
3) If a predator tries to eat a bad-tasting ithomiine butterfly look-alike, it will learn that the butterfly's pattern means bad taste. And it will learn to avoid ithomiines at the same time.

SCENARIO 2

The experiments will depend on the hypotheses the kids come up with. For example, possible experiments to test if scent or displays attract the females might include collecting males and putting them in a sack or other container so that the females can't see the males but can smell them, and collecting males and putting them in clear, airtight cages so that females can see the displays but can't smell the males.

As mentioned in the scenario, scientists are not sure exactly how the females are attracted to the males. Many scientists believe the males use the oily perfumes to make special chemicals called pheromones and that the pheromones attract the females. The displays of the territorial males may also help the females find the males once the females get fairly close.

SCENARIO 3

Durian tree—flying fox; Angraecum orchid—hawk moth; Brownea tree—hermit hummingbird

SCENARIO 4

Leaf-cutter ants grow fungus in their underground nests. They chew up bits of leaves, stems and flowers, which they cut from certain types of plants. These chewed-up plant parts serve as a kind of compost for the fungus to grow in. Then they eat some of the fungus. The fungus wouldn't be able to use the nutrients in the leaves if the ants didn't chew them first.

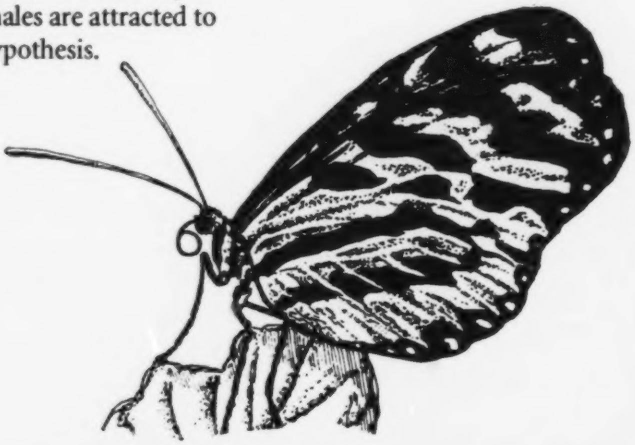
1 The bright colors and bold patterns of ithomiine (ih-THO-mee-ine) butterflies aren't just pretty decorations. They actually warn would-be predators that the butterflies contain poisonous chemicals and taste bad. (If a bird or other predator catches one of these butterflies, it will spit the butterfly out. And it will learn that butterflies with this pattern taste bad.)

In the rain forest where the ithomiine live, there are other butterflies that look almost exactly the same as the ithomiines. But these "mimics" don't taste bad and aren't poisonous.

1. Why might it benefit an edible butterfly to look like an ithomiine butterfly?
2. Imagine you're an ithomiine butterfly living in a forest of edible butterflies that look just like you. Also imagine that there are more of these edible butterflies in the forest than there are poisonous ones like you. Is it more likely that you'll be hunted or avoided by predators? Why?
3. In the forest where the ithomiines live, there are other kinds of poisonous butterflies that look like ithomiines. Why might it be advantageous for the ithomiines to have these poisonous look-alikes?

2 In Central and South American rain forests, brilliantly colored male orchid bees fly from orchid to orchid, collecting oily perfume from the flowers with pads on their legs. Some of these males stake out a mating territory and fly in unusual patterns and buzz noisily. Females are attracted to these males.

No one knows exactly why or how the females are attracted to the males. It's possible that the females are attracted by the sight and sound of the male displays, by the scent of the males, or in some other way. Come up with a hypothesis to explain how the females are attracted to the males and design an experiment to test your hypothesis.



SUPER-SLEUTH SCENARIOS: PART 2

3 In tropical rain forests around the world, many animals transfer pollen from plant to plant, enabling plants to produce seeds. Many flowers are shaped in certain ways or have particular colors or smells that attract specific animals. Given the descriptions of the different flowers and animals, match each plant to its pollinator.

PLANT	**POLLINATOR**
durian tree	hawk moth
Angraecum (an-GRAY-come) orchid	hermit hummingbird
Brownea (BROWN-ee-ah) tree	flying fox (a type of bat)

- Durian tree flowers and *Angraecum* orchids are white; *Brownea* tree flowers are bright red.
- *Brownea* tree flowers have no scent; *Angraecum* orchids have sweet-smelling flowers; and durian tree flowers are musty smelling.
- The nectar in *Angraecum* orchids is located at the end of a tube that may be 12 inches long.
- Hawk moths and flying foxes are active at night.
- Hermit hummingbirds have long bills.
- Durian tree flowers and *Angraecum* orchids open only at night.
- White flowers are easier to see at night than dark-colored flowers.
- Hawk moths have a long tongue that they can uncoil.
- Bats are usually attracted to musty-smelling flowers.
- Hermit hummingbirds are active only during the day.

4 In a Central American rain forest, leaf-cutter ants visit certain plants. They cut off pieces of leaves, stems, and flowers from the plants and carry the pieces back to their underground nests. There they clean and chew up the plant parts and put them into piles. Given the following information, why do you think these ants bring these plant pieces back to their nests?

- Leaf-cutter ants don't eat leaves, stems, or flowers.
- No one has ever seen these ants eating outside their nests.
- Leaf-cutter ants take leaves, stems, and flowers from only certain kinds of plants.
- Scientists have tested the leaves of some of the plants the ants don't use and have discovered that the leaves have natural fungicides (chemicals that will kill fungus) in them.
- Mounds of fungus grow inside leaf-cutter ant nests.
- If scientists remove the fungus growing in the ant nests, the ants die.
- If scientists remove the ants from their nest, the fungus growing in the nest dies.

WE CAN ALL BE EXPERTS

PROCEDURE

1. Optional—In advance, in addition to or as a substitute for the questionnaire and expert cards provided, you may want to have the children help prepare the questions and answers. Explain the types of information needed. Give examples of questions and answers, such as the ones provided at the end of this activity. Ask each child to create several question/answer pairs. Provide the reference materials. Assist with the researching as needed. Then prepare the expert cards and questionnaires. See step 3 to determine how many duplicates of each card are necessary.

2. Explain to students that they will be responsible for collaborating on a research project. You may want to increase the role-playing facet of this activity by calling this a "world research conference." Each child will be an "expert" on one or more topics of global affairs. Together they will be responsible for helping each other complete a copy of the research questionnaire. Have volunteers find each country that will be discussed on the world map.

3. You will probably want to break the group into teams of six to eight persons. If the group works well together, however, you may want to let them try to work on the questionnaires in one large group.

If you plan to divide the group into teams, you will need to make duplicates of the expert cards, one for each team. Most teams will need the supervision of an older person. Depending on the size of your group and the number of helpers available, you may need to run this activity at the same time that some children are working individually.

4. Pass out questionnaires to each student in each team. Pass out one to three expert cards to each person. You may want to organize this so that each person has answers that are related to each other, either by subject area or by geographic region. Pass out writing materials as needed. Ask each child to fill out the questionnaire by using the advice of the other "experts." Allow the teams (or the big group) to decide on the process. They may choose to go around individually, to work together in one group, or to use some other process.

5. When all the teams are finished, bring the group back together. Go over the questions and answers.

6. Discuss the process—how it felt to work together and to be responsible for helping each other and how the group might have worked more effectively. Also, discuss the answers—what were the reactions to the information, which of the differences sounded better than life in this country, which sounded worse (and why), what are some other differences that were not mentioned, and what do other countries have in common with the United States.

OBJECTIVES:
Show that differences exist around the world. (It is not necessary for the children to memorize facts about other countries.) Develop an appreciation for customs in other lands. Understand that our way of doing things is not always the most sensible way for other people in other places. Practice cooperation and realize how collaboration helps to get work done. Increase geographic awareness of where countries are on the map. Improve analytical thinking and research skills.

AGES:
Intermediate

SUBJECTS:
Nutrition, health, reading, oral communication, writing and language arts, geography, science

MATERIALS:
A questionnaire for every child, one or more 4" x 6" expert cards with information for the answer to one question for each child, pencils or pens, paper, world map, and optional reference materials, such as books and magazines

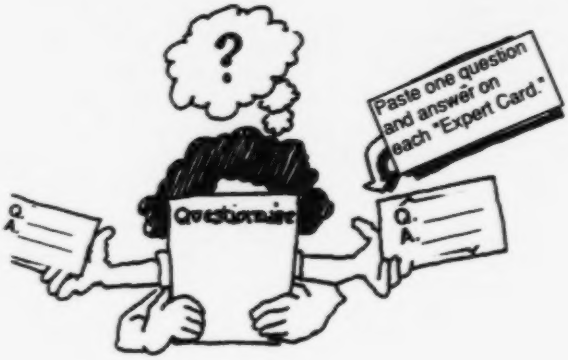
7. Journals—Provide time for children to put their questionnaires into their journals and to make entries about how it felt to collaborate and what was learned about ways of life in other lands.

MODIFICATIONS

For younger children, do question/answer examples 3, 4, 7, 8, 9, 12. Omit question/answer examples 1, 2, 5, 6, 11.

For older children, try letting the teams work without adult supervision, giving the children more responsibility for problem solving.

EXPERT CARDS: PART 1


?
Paste one question and answer on each "Expert Card."
Questionnaire
Q.
A.
Q.
A.

Q. What is one way that jobs are different in West Germany than they are here?

A. In West Germany the factories can't close without telling the workers a long time before the factory closes. A child from West Germany might not understand that in America a factory can close and move away quickly. A parent who worked for that factory might not have time to find a new job.

Q. What is one way that eating meals is different on an Israeli kibbutz than it is here?

A. In Israel some families live and work together on a big farm called a kibbutz. On a kibbutz hundreds of people eat together in big dining rooms. A child from a kibbutz would think it was funny that in America families eat by themselves.

Q. What is one way that jobs are different in El Salvador than they are here?

A. In El Salvador jobs are hard to find. One out of three people has no job. A child from El Salvador might not understand why Americans think it is bad when one out of ten people cannot find work.

Q. What is one way farming is different in the People's Republic of China than it is here?

A. In China fertilizer to help make plants grow is made from animal waste. In the United States, most fertilizer is made from chemicals. A Chinese child might not understand why American farmers spend hundreds of dollars to buy chemical fertilizers.

Q. What is one way meals are different for families in India than they are here?

A. In India the father gets food first because he has to be able to work. The sons and daughters and the mother get food if any is left. An Indian child might not understand that in America, when there is not enough food, children eat first.

Q. What is one way farming in Japan is different than it is here?

A. In Japan farmers grow one-third more grain on each acre than American farmers do. A Japanese child might not understand why our big American farms grow less food per acre.

EXPERT CARDS: PART 2

Q. What is one way that having babies is different in Norway than it is here?

A. In Norway fewer babies die before their first birthday than the babies here. This is a sign that they are better nourished. A child from Norway might not understand why more babies in America die of hunger or sickness.

Q. What is one way farming is different in Nigeria than it is here?

A. In Nigeria it is hard for small farmers to borrow money to buy seeds and fertilizer. Some pay 192 percent per year on interest. A child from Nigeria might be surprised that farmers in America can usually borrow money and pay interest of 20 percent per year.

Q. What is one way that farming is different in Somalia than it is here?

A. In Somalia on small farms mothers in the family grow all the food that the family eats. A child from Somalia might not understand why some Americans think growing food is men's work.

Q. What is one way that food shopping in Sweden is different than it is here?

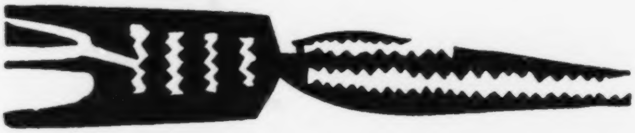
A. In Sweden half of the families go shopping in cooperative food stores, which they can help control by voting. A child from Sweden might not understand that most American families shop at supermarkets that they don't control.

Q. What is one way that drinking water is different in Ethiopia than it is here?

A. In Ethiopia most homes have no running water. In small villages a mother and her children may have to walk five hours a day to get water. A child from Ethiopia might be surprised how easy it is to get water in America and how much water most Americans use.

Q. What is one way that having babies is different in Brazil than it is here?

A. In Brazil many more babies die before their first birthday than babies here. This is a sign that they are not as well-fed. A child from Brazil might think it unusual that American babies get more to eat and don't get as sick as babies in Brazil.



WE CAN ALL BE EXPERTS

1. What is one way that jobs are different in West Germany than they are here?

2. What is one way that jobs are different in El Salvador than they are here?

3. What is one way meals are different for families in India than they are here?

4. What is one way that eating meals is different on an Israeli kibbutz than it is here?

5. What is one way farming is different in the People's Republic of China than it is here?

6. What is one way farming in Japan is different than it is here?

7. What is one way that having babies is different in Norway than it is here?

8. What is one way that farming is different in Somalia than it is here?

9. What is one way that drinking water is different in Ethiopia than it is here?

10. What is one way farming is different in Nigeria than it is here?

11. What is one way that food shopping in Sweden is different than it is here?

12. What is one way that having babies is different in Brazil than it is here? ____________________

RATERS OF THE PLANET ECO

OBJECTIVES:
Distinguish between renewable and non-renewable resources. Rate products according to their potential environmental impact. Make value decisions relating to consumer choices.

AGES:
Intermediate, advanced

SUBJECTS:
Social studies, science

MATERIALS:
Student rating sheet provided

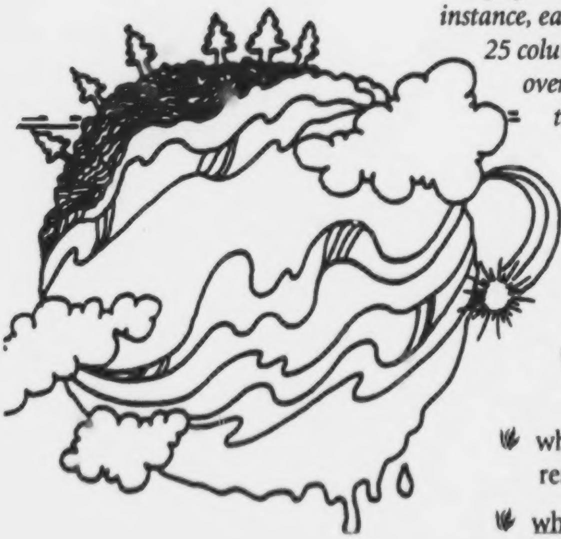
Imagine a planet where environmentally aware citizens take an active role in maintaining a healthy environment and where consumer decisions are based on a conscious attempt to reduce waste and save energy. In this investigation your students will assume the point of view of citizens from such an environmentally-conscious planet. As "Raters of the Planet Eco" their task is to evaluate the environmental impact of a variety of Earthling products. They will consider how consumer choices can affect the environment and will write recommendations for citizens of planet Earth based on their observations.

1. Read the following assignment to your students:

As we look down upon planet Earth, we see our neighbors are suffering from many problems. You, as citizens of the planet Eco, have been assigned to a special task force to help reduce Earth's environmental problems. Your specific assignment is to rate some of the Earthling products. You will find that some of the products are useless and that others are quite inventive or worthwhile. We would like you to collect a sample of a useless product and a worthwhile product during your investigation. We want to help Earthlings reduce their wastes and save energy. We have learned that Earthlings are using up their metals, oil, and gas, and that their wastes are piling up. For instance, each year Earthlings throw away enough aluminum cans to make 25 columns from the Earth to their moon! Their landfills are overflowing with all kinds of broken gadgets, packaging, and things they use once and throw away.

2. Distribute the rating sheets provided in this unit and review the criteria to be considered when rating products. To determine a product's environmental impact, students will consider the following:

- the amount of energy the product uses
- the longevity of a product—whether it's disposable or built to last
- whether the product is made from renewable or nonrenewable resources
- whether the product is biodegradable or nonbiodegradable



You may need to review nonrenewable and renewable resources. Renewable resources are materials that can be generated again, such as wood. Nonrenewable resources are those that cannot be renewed or created again in our lifetime, such as oil or gas.

3. When students have completed their ratings, ask them to bring a sample of a useless product or a worthwhile product to the classroom. Display the products and have students debate the merits of various

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items. Ask for some reports from the rating sheets and discuss recommendations that could be made to planet Earth to reduce waste and save energy. You may want to conclude the activity with a class vote to see if students can agree upon the most useless or most useful Earthling product.

EXTENSIONS

Take a class trip to a landfill in your community to see how Earthling wastes are piling up. Find out if any of the wastes are recycled and how students can contribute to the recycling effort.

Have students write a collective letter to the editor of the local newspaper using the most constructive recommendations generated by the "raters" to the citizens of planet Earth.

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RATERS OF THE PLANET ECO

PRODUCT RATING SHEET **RATER'S NAME** ____________________

Choose five Earthling products and rate their impact on the environment. As you select products to rate, look for at least one example of a product you feel is useless and an example of a very useful product.

PRODUCT	ESTIMATED ENERGY USE			LONGEVITY		MATERIAL	
	HIGH	MEDIUM	LOW	DISPOSABLE	LONG-LASTING	NONRENEWABLE/ NONBIODEGRADABLE	RENEWABLE/ BIODEGRADABLE

Which product(s) would you describe as useless? Why? ____________________

____

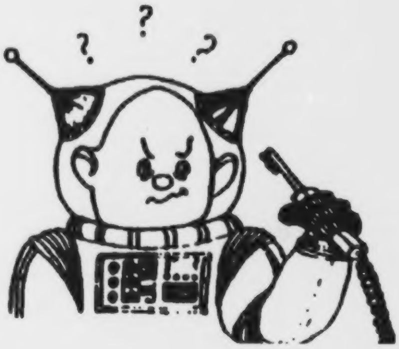
Which product(s) do you feel are worthwhile or useful? Why? ____________________

____

____

ADVICE TO EARTHLINGS

Based on your ratings of Earthling products, make some recommendations which would help Planet Earth to reduce wastes and save energy. Be specific.



Note: Collect a sample of a useless product and a useful product and bring them in for other raters to inspect.

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23.

LIVEN UP YOUR CLASSROOM

One way to increase the effectiveness of your environmental education program is to create a stimulating and inviting learning environment in your classroom.

One of the easiest things you can do is collect materials from the out-of-doors to create discovery tables, question of the day displays, and interactive bulletin boards. Seeds, fruits, leaves, insect nests, shells, and other easy-to-find natural objects can all help liven up an empty room. (Note: It's important that you only take things from the wild that won't disrupt the natural environment. For example, picking rare plants would send the wrong message to your students.) If you have access to a large container, you might want to create a terrarium for native plants and insects and other small creatures. (See ICE Manual #M0006 for directions about how to build a terrarium.)

> *I hear and I forget. I see and I remember. I do and I understand.*
>
> —Chinese Proverb

You can also get students to help decorate a room by having them generate posters, poetry, models, and exhibits that can be displayed. In The Gambia, a Peace Corps Volunteer painted scientific illustrations directly on her classroom walls. Another helped students paint a large map of the world on the outside of the school building. And in another classroom, students researched specific endangered species and drew posters to create a "Gallery of Endangered Species." By taking a tour of the Gallery, students learned more about each species, including why it was in danger of becoming extinct, where it lived, and how it was adapted to a specific habitat.

In this section, we have included directions for creating a three-dimensional bulletin board that illustrates a marine food web. You can adapt this idea to create a bulletin board that shows the creatures that live in a habitat near you. We've also included a bulletin board/display idea that you can use to compare energy use and food production.

ACTIVITIES IN THIS SECTION

1. **A WEB ON THE WALL**, reprinted with permission from *Ranger Rick's NatureScope: Diving Into Oceans* published by the National Wildlife Federation (1987).
2. **A LOOK AT FOUR FOOD CHAINS**, reprinted from *Connections: A Curriculum in Appropriate Technology for 5th & 6th Grades*, published by the National Center for Appropriate Technology (1980).

A WEB ON THE WALL

OBJECTIVES:
Name some marine animals and describe what they eat. Define food chain and food web. Explain the importance of phytoplankton in marine food webs.

AGES:
Primary

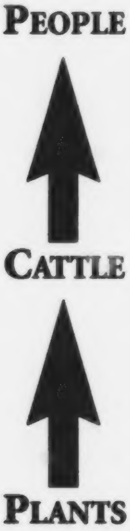
SUBJECTS:
Science, art

MATERIALS:
Bulletin board, pictures of plankton, chalkboard or easel paper, construction paper, scissors, small bags, tape, glue, staplers or tacks, markers or crayons, reference books, paper plates, paper, cotton or tissue paper (optional), pantyhose, clear container, needle and thread, rubber band, hand lenses and microscopes, wire

Either directly or indirectly, almost every animal in the ocean depends on microscopic phytoplankton for food. By making a three-dimensional bulletin board, your kids can see that phytoplankton is important to many kinds of animals, from scallops to whales.

Before you begin, copy each of the names in bold from the information under "Members of the Web" on separate slips of paper and put the slips in a bag. Then, on construction paper, copy and enlarge each of the outlines pictured near the names of the different marine animals. (The number beside each name indicates the number of copies of each outline to make.) You should make each outline at least a few inches long and use different-colored paper of similar outlines, such as the anchovy and mackerel. Then put the outlines for each creature in a separate bag and label each bag.

Start the activity by discussing the concept of food chains. Ask the kids to raise their hands if they had a hamburger, steak, or some other kind of beef for dinner last night. Write "people" on a chalkboard or sheet of easel paper, then ask the kids if they know what animal beef comes from. Add the word "cattle" below "people" then ask what cattle eat. Add the word "plants" below "cattle," then draw arrows between the three words (see diagram). Explain that you've just drawn a simple food chain. A food chain shows the transfer of energy, in the form of food, from one organism to another.

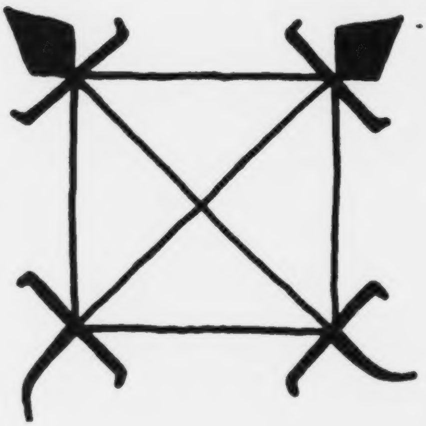


Explain that plants form the base of almost every food chain on Earth. Plants use energy from the sun to make their own food through photosynthesis. In turn, some animals eat plants, and other animals eat the plant-eating animals.

Now tell the kids that, like animals on land, most animals that live in the ocean depend on plants for food. And the most important marine plants are phytoplankton. Show the kids pictures of different kinds of phytoplankton and explain that millions of these tiny plants drift near the ocean's surface. Tiny animals called zooplankton eat the phytoplankton, and so do clams, corals, and small fish. (Show the kids pictures of zooplankton.) Ask the kids if they can guess what kinds of animals eat zooplankton. (Some fish, jellyfish, and even some kinds of whales.) Then explain that many larger fish and other animals eat the animals that feed on zooplankton.

Next explain to the kids that they'll be learning more about marine organisms. Divide the group into 12 teams and have each team pick one of the slips of paper you made earlier. Explain that all of these organisms are found in the Pacific Ocean off the coast of Washington. Each team will be doing some research to answer these questions about their organism:

- What does it look like?
- About what size is it?
- Where does it live in the ocean—near the surface, on the bottom or in the mid-waters?
- What does it eat, and how does it get its food?



Give the kids reference books and time to answer the questions. If the kids have trouble finding a specific animal or plant, such as "giant Pacific octopus," have them look for general information under the heading of "octopus."

When everyone has finished the research, tell the kids they'll be making a three-dimensional bulletin board that shows all of their organisms and what they eat. Explain that each team will make at least one three-dimensional figure of their animal or plant. They can make the whole body of some animals such as the scallop or octopus and just the head and mouth of the others. See "Building the Bulletin Board" for how to make a construction-paper mouth that can be adapted to represent most of these animals, along with some other helpful hints. (Since there are so many types of plankton, have the plankton teams use the simple outlines that you enlarged to make their figures.)

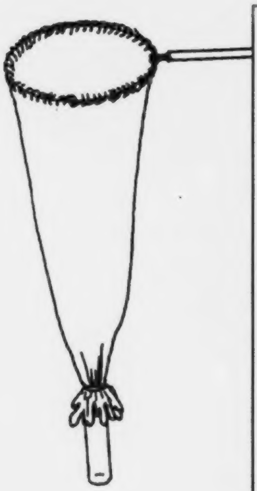
Now pass out construction paper, scissors, glue, and markers or crayons, and let the kids start making their figures. Teams that finish early can cover the bulletin board with a background of green or blue construction paper and add a brown ocean floor. As the teams finish, have them staple or tack their animals to the bulletin board. (See "Building the Bulletin Board.")

Then starting with the phytoplankton group, have each team explain what their creature needs to survive. (For example, phytoplankton need sunlight and nutrients.) You can check their answers against the information under "Members of the Web." Also have the kids check the other creatures on the board to see if their animal eats any of them. If so, the kids should take one or more of the outlines from the bags you filled earlier and tape them inside their animal's mouth or on the body part that captures food. For example, the octopus team could tape a scallop to one of the octopus' arms. Then the kids should draw a line from their animal to the animal it eats —in this case from the octopus to the scallop.

When the bulletin board is finished, ask the kids the following question. (To give the kids more time to think, you may want to have them write down their answers, then discuss them as a group.)

- How is the finished board different from the simple food chain you drew on the board earlier? (It includes many food chains and is more complex.)
- Which animals would probably have trouble surviving if there were no more anchovies or phytoplankton? (If there were no anchovies, all of the organisms except the scallop and plankton would be in trouble. And if phytoplankton disappeared, all of the animals would have trouble.)

Explain that the bulletin board shows a food web—a series of interconnecting food chains. A food web is a more realistic way of explaining the transfer of energy between animals and plants than a food chain because most animals tend to eat more than one kind of food. Be sure to point out that plants (in this case, phytoplankton) almost always form the base of a food web. You can show that even a top predator such as the killer whale depends on these small plants by tracing the connecting lines from the killer whale back to the phytoplankton.



A Phytoplankton Field Trip

After learning about the importance of phytoplankton and zooplankton in marine food webs, your kids can take a close-up look at plankton. If you live near the coast, take the kids on a field trip to the beach or to a salt marsh to collect water samples. (If you live inland, try a freshwater pond.) You can cut off one leg of a pair of pantyhose to make a plankton net. First cut off the foot and sew the larger end to a circle of wire. Then put the smaller end over the top of a clear container and secure it with a rubber band (see diagram). As you swish the net through the water, the pantyhose will funnel plankton into the container. Use hand lenses and microscopes to look at the plankton you collect. Also see *Pond Life* by Dr. George K. Reid (Golden Press, 1967) and *The Water Naturalist* by Heather Angel and Pat Wolsely (Facts on File, 1982) for more tips on collecting plankton and drawings to help you identify different kinds of plankton.

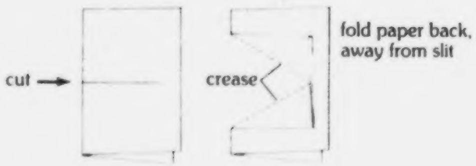
BUILDING THE BULLETIN BOARD

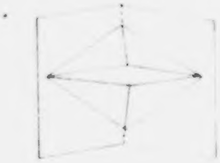
Most of the animals' mouths can be made out of construction paper. Here's how:

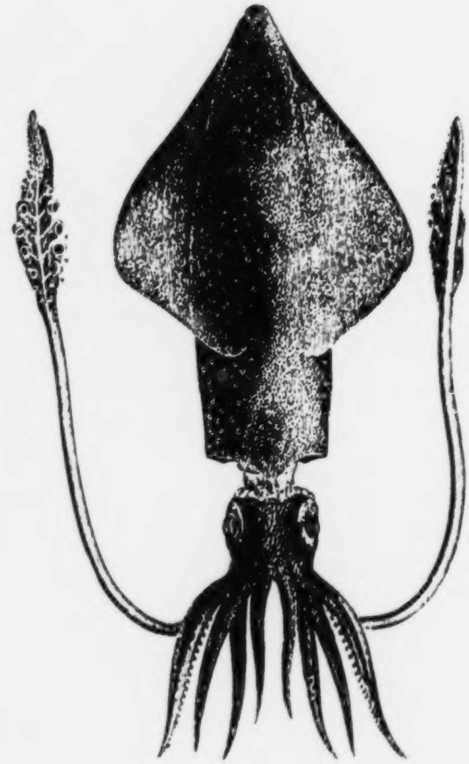
1. Fold a piece of construction paper in half. (The size of the paper will vary, depending on how big a mouth you're making.)
2. Make a perpendicular cut on the folded side of the paper, about midway between either end.
3. Fold back one side of the cut to make a triangle, Strongly crease the fold. Repeat with the other side of the cut.
4. Unfold both triangles, bend them the other way, and crease them again.
5. Unfold the paper and push the folds outward. Then bend the paper slightly to open and close the mouth.
6. Depending on the animal, you may want to glue the mouth to a larger piece of paper that's shaped to resemble the rest of the head or body. Or you can just add eyes, teeth, and other features around the mouth.

Here are some other tips:

- Make the jellyfish and scallop out of paper plates.
- Fringe paper to make the humpback whales' baleen.
- Make a lot of plankton figures to represent the abundance of these tiny plants and animals.
- Try to make the sizes of the figures in proportion to each other. For example, the whales and shark should be larger than the mackerel and anchovy.
- Place the creatures according to where they live in the ocean. For example, the octopus should be near the ocean floor and the anchovy should be near the surface.
- Make the figures as three-dimensional as possible. Some animals could be stuffed with cotton or tissue paper to make them stick out from the board.
- You may also want to make name tags for each animal on the bulletin board so they're easier to identify.







MEMBERS OF THE WEB

Phytoplankton (4)
- microscopic plants that drift near the ocean's surface
- absorb sunlight and nutrients from water
- diatoms are one of the most common kinds of phytoplankton

Zooplankton (12)
- tiny animals that live near the ocean's surface and in deeper waters
- some kinds of zooplankton feed on phytoplankton; others feed on other zooplankton
- most are very small, though some, such as *krill*, grow to be several inches long
- some, such as *copepods*, have feathery body parts that help filter phytoplankton from the water

Rock scallop (2)
- a shellfish that lives on the ocean bottom
- largest living scallop—grows to be 4 to 11 inches long
- eats phytoplankton, along with other small particles of food
- filters food through its gills (gills are also used for breathing)

Northern anchovy (12)
- a small fish that usually stays near the ocean's surface
- about 9 inches long
- feeds mostly on zooplankton
- netlike parts of its gills strain zooplankton from water

Chub mackerel (4)
- swims near the ocean's surface and in deeper waters
- about 18 inches long
- feeds on krill (a kind of zooplankton), squid, and anchovies

Lion's mane jellyfish
- drifts near the ocean's surface
- one of the largest jellyfish in the world—most are 1 to 2 feet wide, but some may be 8 feet wide
- its stinging tentacles paralyze prey such as zooplankton and young fish

Giant Pacific octopus
- spends most of its time on the ocean bottom
- feeds on shrimp, crabs, scallops, abalones, and clams
- traps prey with its arms, then tears it with its sharp beak

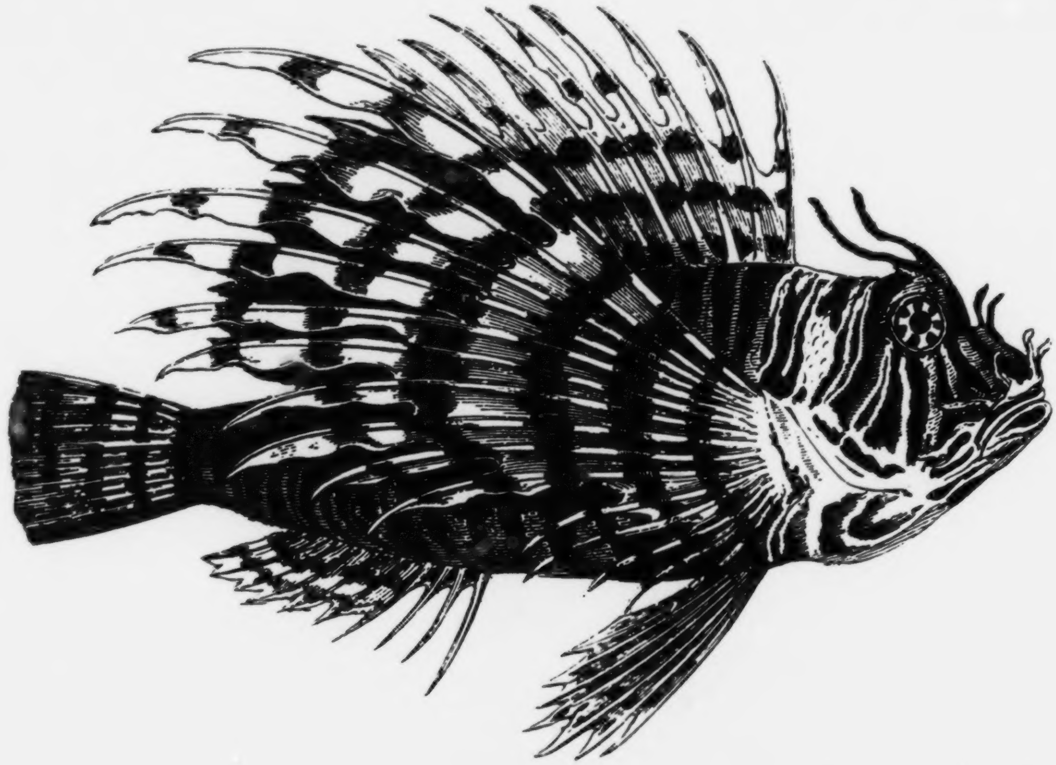
Blue shark
- found near the ocean's surface and in deeper waters
- about 12 feet long
- feeds on squid and fish such as anchovies and mackerel

Northern fur seal (1)
- spends most of its time near the ocean's surface
- can grow to be 6 feet long
- may dive 300 feet in search of prey
- eats squid and small fish such as anchovies and herring

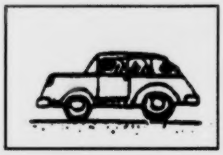
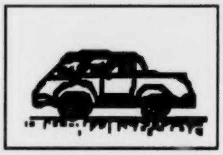
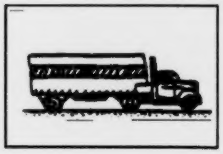
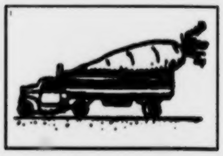
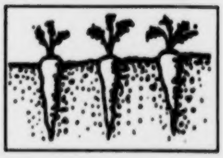
Humpback whale (1)
- found near the ocean's surface and to depths of about 130 feet
- about 53 feet long
- eats mostly krill and other types of zooplankton; sometimes eats anchovies and other small fish
- huge, brushlike baleen on upper jaw strain zooplankton from water

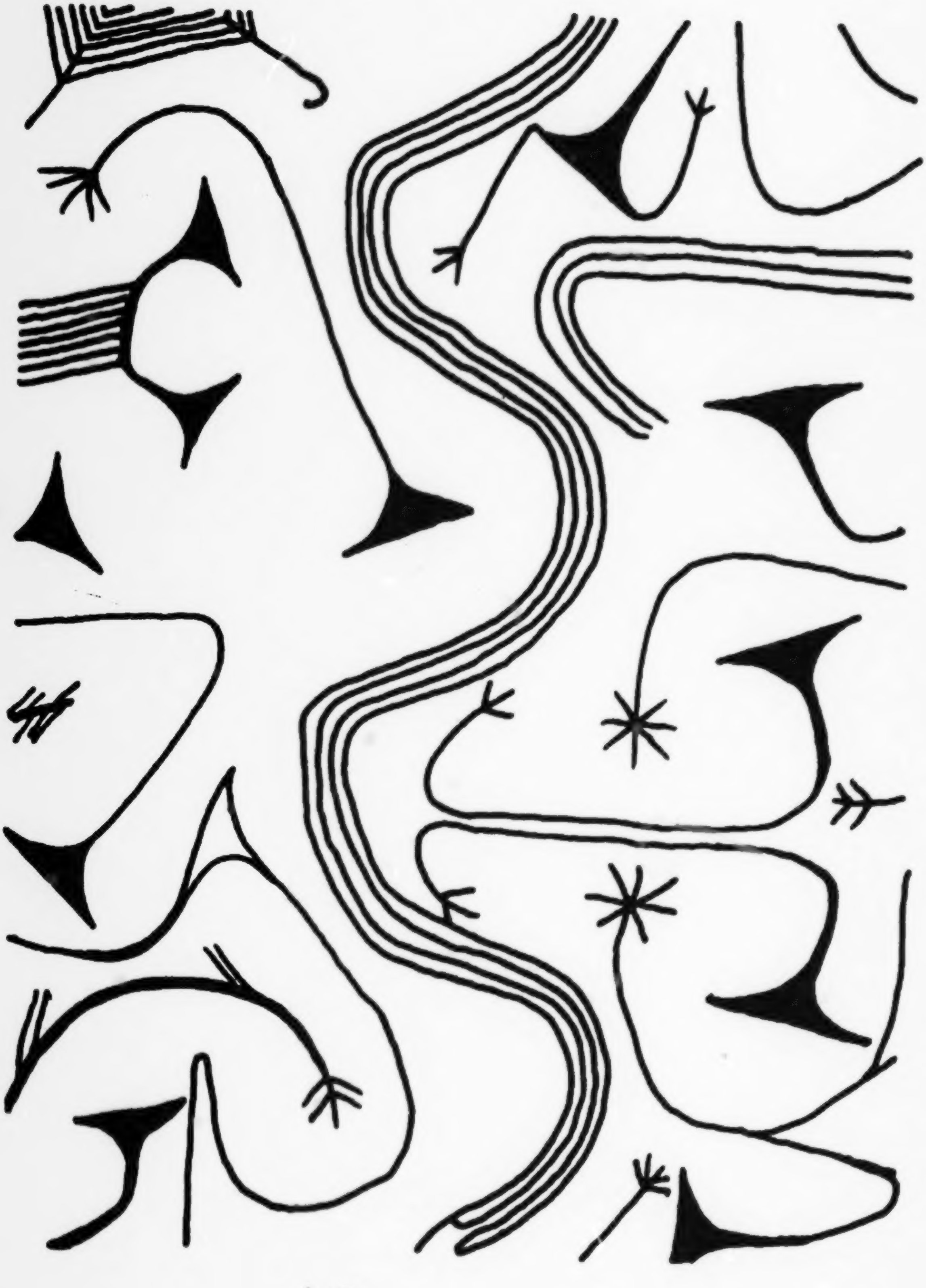
Killer whale (orca)
- usually found near the ocean's surface
- may be 31 feet long
- eats other whales (such as humpbacks), seals, and fish such as mackerel

Brandt's cormorant
- a seabird that nests on the coast and feeds in coastal waters
- dives into water to catch small fish such as herring and anchovies



A LOOK AT FOUR FOOD CHAINS

EAT IT	EAT IT	EAT IT	EAT IT	
↑	COOK IT	COOK IT	THAW IT. COOK IT. THROW AWAY THE PACKAGE	
↑	↑	TAKE IT HOME	TAKE IT HOME AND PUT IT IN THE FREEZER	
↑	↑	YOU DRIVE TO MARKET AND BUY IT	YOU DRIVE TO MARKET AND BUY IT	
↑	↑	THEY REFRIGERATE IT AT THE MARKET	MARKET KEEPS IT FROZEN	
↑	↑	IT'S TRANSPORTED TO MARKET	REFRIGERATED TRUCK TAKES IT TO MARKET	
↑	↑	↑	IT'S SLICED BY A MACHINE, PACKAGED AND FROZEN	
↑	↑	↑	IT'S TRANSPORTED TO A PROCESSING PLANT	
YOU GROW A VEGETABLE IN YOUR GARDEN	YOU GROW A VEGETABLE IN YOUR GARDEN	SOMEONE ELSE GROWS A VEGETABLE	YOU DRIVE TO MARKET AND BUY IT	



THE INTERDISCIPLINARY CONNECTION

24.

As we've mentioned throughout this manual, environmental education is interdisciplinary. It fits with every other subject in the curriculum—from social studies to home economics. We've already shown the connection between environmental education and language arts, reading, writing, science, art, music, and social studies. In this section, we've included environmental education activities that focus on geography and math. As you've already seen, many activities have several objectives and can be used to satisfy a variety of needs.

The first activity has a geography focus and follows the radiation cloud that was released into the atmosphere when the Chernobyl nuclear power plant exploded in Ukraine. The second activity links environment and math, as students work with real data from a research project taking place in Brazil that looks at deforestation and the amount of space species need to survive.

Check the Bibliography for additional resources that focus on the interdisciplinary nature of environmental education. Also, see page 409 for activities that link technology and the environment.

ACTIVITIES IN THIS SECTION

1. **POLLUTION PATHWAYS**, reprinted with permission from *Ranger Rick's NatureScope: Pollution—Problems and Solutions* published by the National Wildlife Federation (1990).
2. **SIZING UP RESERVES**, reprinted with permission from *Ranger Rick's NatureScope: Endangered Species—Wild and Rare* published by the National Wildlife Federation (1988).

POLLUTION PATHWAYS

OBJECTIVES:
Describe some of the ways rain forest destruction affects the plants and animals that live there.

AGES:
Intermediate, advanced

SUBJECTS:
Science, geography

MATERIALS:
Large world map, copies of area map and Pollution Pathways handout, bulletin board, pushpins, atlases and/or world map

There are no state or national boundaries in the atmosphere. Winds can carry pollutants hundreds or even thousands of miles from their origin, creating air pollution in other regions. By tracing the movement of radiation released during an accident at the Chernobyl nuclear power plant, your kids will see how air pollution can become a global issue.

Before you get started, hang a large world map on a bulletin board. (Later, you'll be using pushpins to mark different places on the map.) Then begin by asking the kids to name some sources of air pollution. Explain that as weather systems move through an area, winds pick up and carry air pollutants. Eventually these pollutants fall from the sky as dry particles, or they are washed back to earth by rain, snow, or fog. Also explain that, in general, the distance air pollutants travel depends on how high in the atmosphere they go. Pollutants that don't rise very high tend to be deposited relatively close to their source. But pollutants that are lifted high in the atmosphere may travel thousands of miles before they drop back to earth.

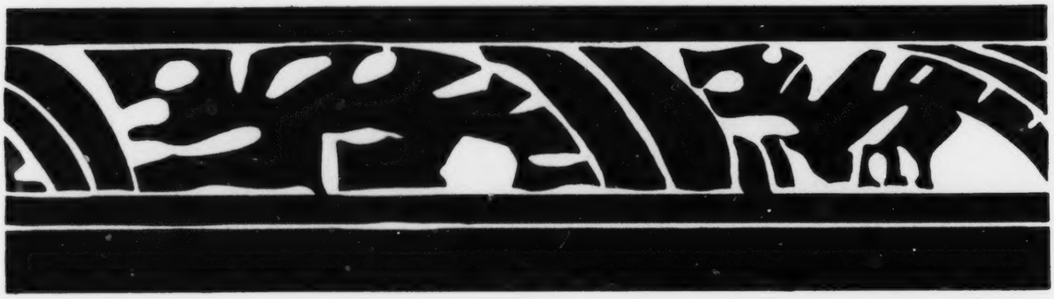
Next point out the location of the Chernobyl nuclear power plant on a world map (see page 401), and use the information under "Explosion at Chernobyl" on the next page to tell the kids about the accident. Explain that the radioactive gases and particles released by the explosion formed a toxic cloud that soon split into two parts. Point out that the plant released radiation for 10 days after the explosion, and since the winds shifted several times during this period, radiation was carried in many different directions. By tracking the radioactive particles and gases released by the explosion, scientists learned a lot about how air pollutants travel from place to place.

Now pass out a copy of page 400 to each person and explain that each of the 29 "Pollution Points" on the page describes when the radioactive cloud from Chernobyl reached a certain location. The points are grouped under the headings of Day 2, Day 3, and so on. This indicates how many days after the explosion it took the radioactive cloud to reach a certain location. For example, the radiation reached Stockholm, Sweden, on April 28, the third day after the explosion. (Note: The information on page 400 doesn't include all the countries that received radiation from Chernobyl, and in some cases, the dates indicating when radiation reached certain areas are approximations.)

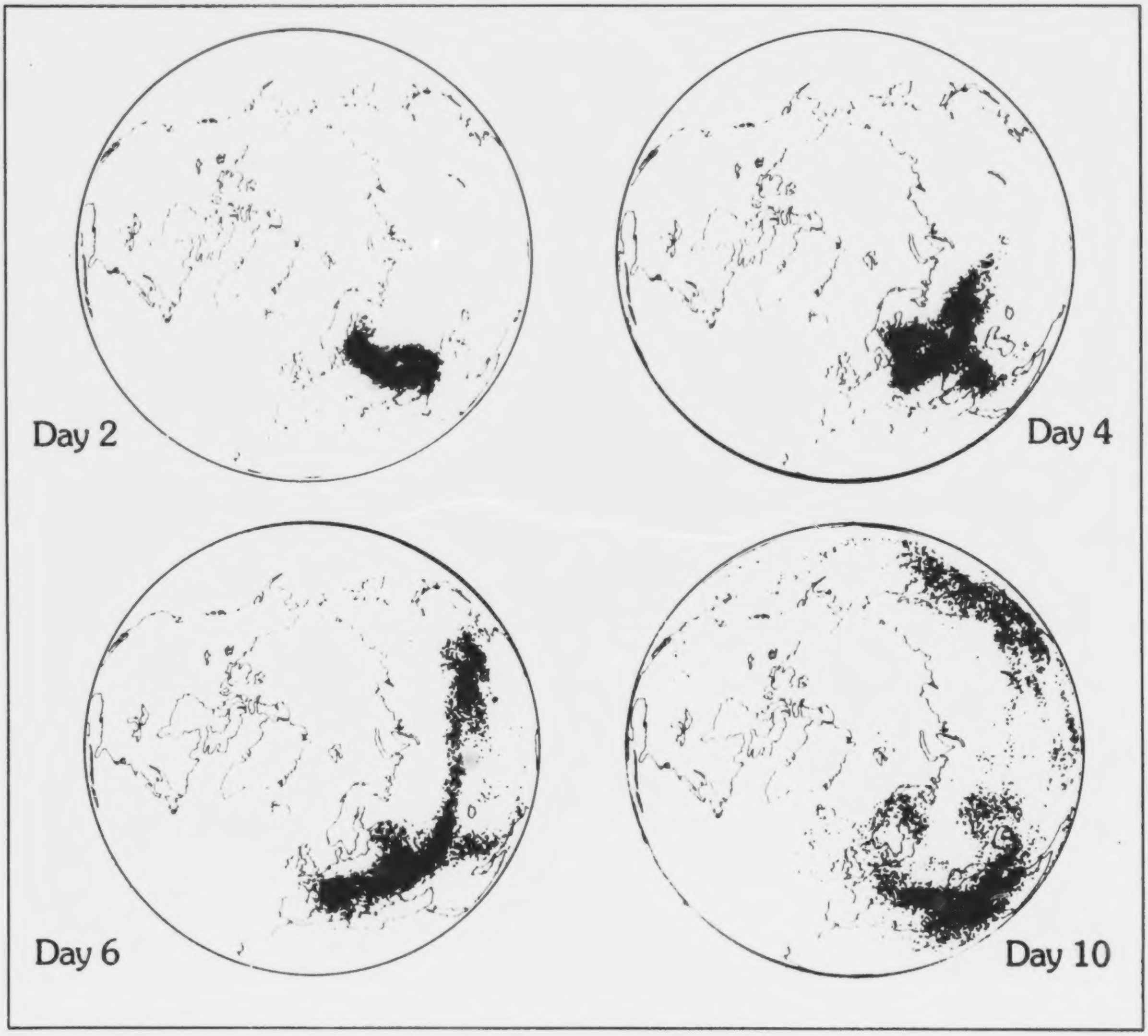
Next split the group into two teams and explain that the members of each team will be working together to map the "Pollution Points." Mark Chernobyl's location with a pushpin on the world map. Have the teams gather close to the map and explain that the mapping will start with someone from the first team reading pollution point 1 out loud. He or she will have 40 seconds to find that city on the map and mark it with a pushpin. Team members can help the player by giving directional tips, such as “move closer to Spain,” but they can’t point to any specific location on the map. If the team members find the point within 40 second, his or her team gets one point. If not, the other team gets a chance to find the correct location. Have the teams take turns locating the points until all 29 points have been mapped.

Next, give each person a copy of page 401 and set out some atlases and/or world maps. Tell the kids that they’ll plot some of the points on the map so that they’ll have a record of where much of the radiation released from Chernobyl traveled. They can use the atlases and world maps to help them find the points. (Tell the kids that, because of the limited area shown on their maps, they’ll be able to plot only the first 22 points.) Have the kids write in the number of the day for each location (not the number of the pollution point). This way their maps will show how far the pollution traveled within a certain number of days. For example, when they plot pollution point 1, they’ll write a small number “2” where Gdansk is located in Poland.

After the kids have finished mapping, ask them to describe how rainfall affected the amount of radiation that fell on certain areas. (More radiation reached the ground in areas where it rained.) Point out to the kids that “pollution on the move” also causes problems in the U.S. Discuss how pollutants produced by coal-burning power plants in the Midwest contribute to acid rain that falls in the eastern U.S. and Canada. Explain that acid rain-causing pollutants pour out of smokestacks that are sometimes more than 1,000 feet tall. These tall stacks were built to reduce air pollution problems near the plants. Unfortunately, the tall-stack solution created pollution problems for other regions. The stacks shoot the pollutants high in the atmosphere, where they’re picked up by high-altitude winds. These winds may carry the pollutants thousands of miles away, resulting in acid rain in other regions.



TRACKING THE RADIATION (DAY 2-DAY 10)


Day 2
Day 4
Day 6
Day 10

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EXPLOSION AT CHERNOBYL

THE BIG BLAST: On April 26, 1986, at 1:23 AM, Chernobyl became the site of the world's worst nuclear power plant accident. Operators were shutting down one of the reactors for maintenance when the power suddenly surged and the reactor exploded. The blast blew the reactor apart and sent radioactive gases and particles as high as 3 miles into the atmosphere. Two plant workers were killed by the explosion. Later 29 others died from radiation exposure.

Within days, more than 120,000 people were evacuated from an 18-mile radius around the plant. As fires inside the reactor burned, helicopters dumped tons of lead, sand, and other minerals on the flames. Despite these efforts, the fires burned for 10 days after the blast, continuing to release radioactive pollutants into the air.

WHERE IT WENT: The explosion resulted in a huge cloud that soon split into two parts. One part of the cloud moved northwest toward Poland and Scandinavia, and then southwest across central Europe. The other part of the cloud moved east across Asia, over Japan and the North Pacific, and eventually reached western North America. (The "Pollution Points" on page 400 track the movement of both parts of the cloud.) And as the reactor continued to burn, it released radiation that moved south and east of the plant. But scientists believe that, in most cases, the amounts of radiation deposited outside the then Soviet Union were relatively low.

EFFECTS OF THE EXPLOSION: The first few weeks following the Chernobyl blast were filled with confusion. Some European countries ordered the destruction of millions of dollars worth of contaminated produce, milk, and livestock. But in other nearby European countries, people were told that there was no danger and that it was safe to consume these products. Farmers suffered huge financial losses when countries in other parts of the world refused to import produce from Europe.

The explosion also strained relations between the Soviet Union and other nations. Many countries were angered by the Soviet Union's delay in reporting the accident (officials didn't announce it until April 29).

CHERNOBYL'S LEGACY: The damaged reactor at Chernobyl now stands entombed in thick layers of concrete and steel, while the other reactors at the plant are again producing energy. But the disaster is still taking its toll. Some scientists predict that within the next few decades, thousands of people who were exposed to the radiation could develop cancer.

POLLUTION PATHWAYS (A)

POLLUTION POINTS

DAY 2—APRIL 27

1. Winds blow radioactive cloud northwest over Gdansk, Poland

DAY 3—APRIL 28

2. Radioactive cloud reaches Stockholm, Sweden.
3. Radioactive cloud reaches Helsinki, Finland.
4. Radioactive cloud reaches Oslo, Norway.

DAY 4—APRIL 28

5. Radiation continues moving north through Scandinavia and reaches Trondheim, Norway.
6. Radiation detected in Copenhagen, Denmark.
7. Winds carry radioactive cloud to Prague, Czechoslovakia.

DAY 5—APRIL 30

8. Cloud moves over Munich, West Germany. Heavy radiation falls when it rains in this area.
9. High amounts of radioactive particles wash out when it rains in Vienna, Austria.
10. Radioactive cloud reaches Geneva, Switzerland.

DAY 6—MAY 1

11. Cloud travels to Rome, italy.
12. Radioactive cloud reaches Budapest, Hungary.
13. Winds carry radioactive cloud to Zagreb, Yugoslavia.
14. Radiation detected in Paris, France.
15. Radioactive cloud reaches Tromso, Norway.

DAY 7—MAY 2

16. Small amounts of radiation measured near Reykjavik, Iceland.
17. Radiation reaches Bucharest, Romania.
18. Winds carry radioactive particles into Brussels, Belgium.
19. Radioactive cloud moves over London, England. High amounts of radiation wash out when it rains north of London.
20. Radioactive cloud detected in Sofia, Bulgaria.

DAY 8—MAY 3

21. Radioactive cloud reaches Glasgow, Scotland.
22. Winds carry radioactive cloud to Athens, Greece.
23. Radioactive particles detected in Ankara, Turkey.

DAY 9—MAY 4

24. Radiation reaches Beirut, Lebanon.

DAY 10—MAY 5

25. Radiation detected in Damascus, Syria.

DAY 11—MAY 6

26. Radioactive particles reach Kuwait, the capital city of Kuwait.
27. Radioactive cloud moves over Xian, China.

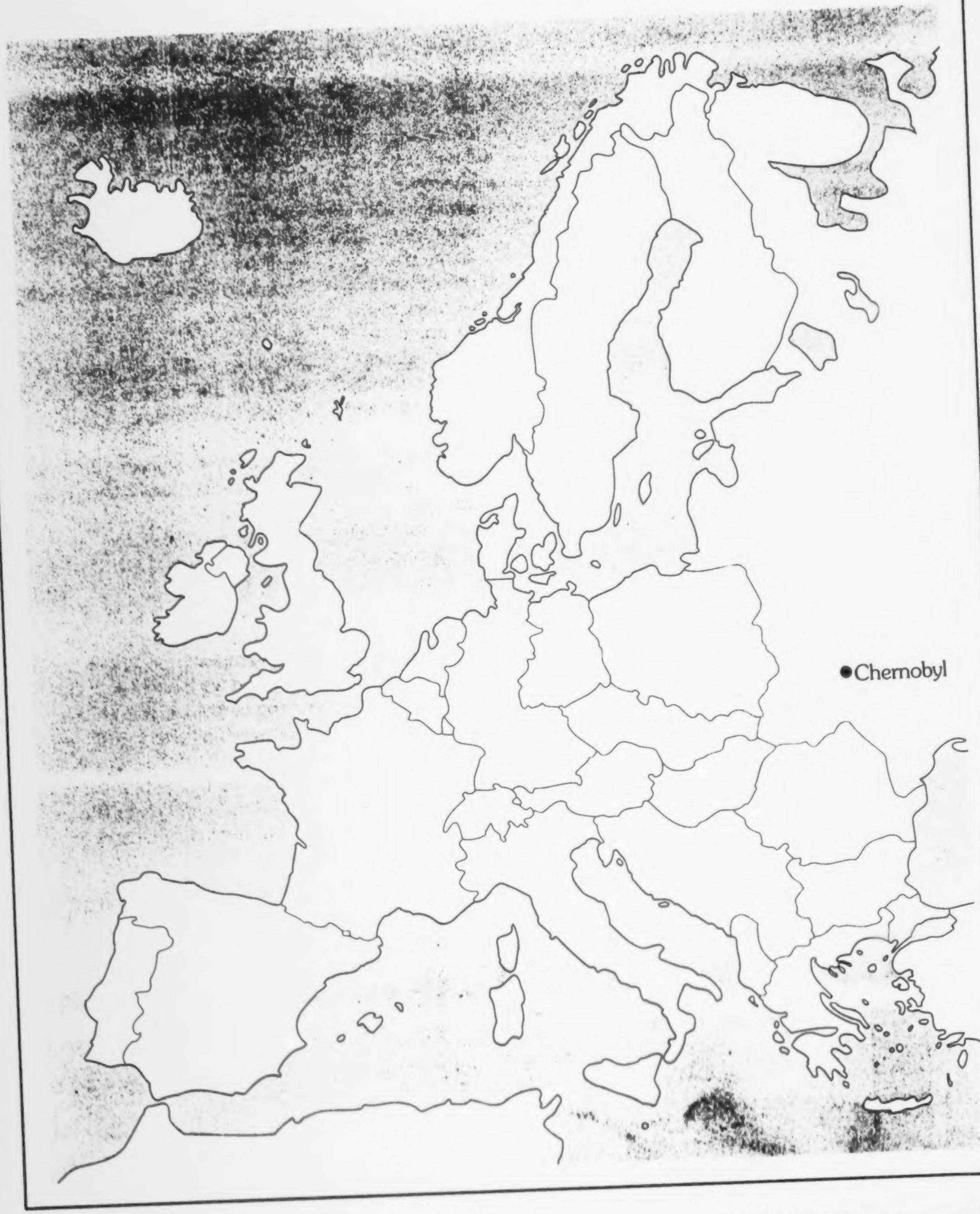
DAY 12—MAY 7

28. Radioactive particles reach Tokyo, Japan.

DAY 13—MAY 13

29. Slight amount of radiation detected in Richland, Washington, in the United States.

POLLUTION PATHWAYS (B)



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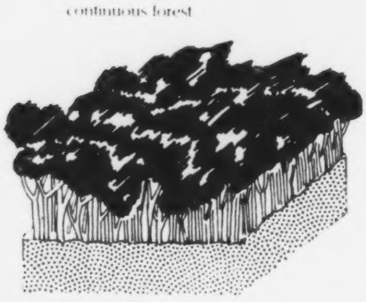
SIZING UP RESERVES

OBJECTIVE:
Describe some of the ways rain forest destruction affects the plants and animals that live there.

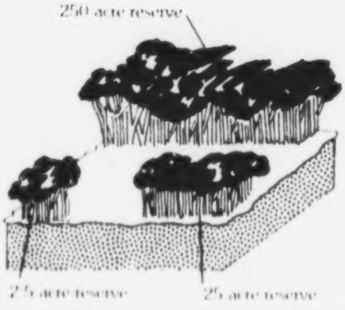
AGES:
Primary, intermediate

SUBJECTS:
Science, math

MATERIALS:
Copies of graphs, chalkboard or easel paper, small electric fan, thermometers, wet cloths



Before



After

If you wanted to create a tropical rain forest reserve in South America that was large enough to protect most of the species that live there, how big would the reserve have to be? No one really knows for sure, but scientists working in Brazil may have an answer sometime in the next few years. These scientists are in the midst of a 20-year study to find out what happens when parts of a rain forest are cut down and how the use of the remaining forest affects the plants and animals that live there. By looking at some of the data these scientists have collected so far, your kids will discover some of the ways tropical rain forest destruction affects certain species. And they'll also learn some of the ways species in a rain forest community interact and how much space it might take to preserve them.

Before you get started, copy the diagram in the margin onto a chalkboard or sheet of easel paper. Then begin by having the kids imagine that a road is going to be built right through the middle of a huge section of tropical rain forest. Also, some of the forested land is going to be converted into pastures for cattle and farmland for crops.

Ask the kids how life in the forest might be affected by these changes. (Some animals might be killed on the road; others might move into less developed areas; more development might come into the area because of the access the road provides, causing further destruction of the rain forest; entire species could become extinct.) List their answers on a chalkboard or sheet of easel paper.

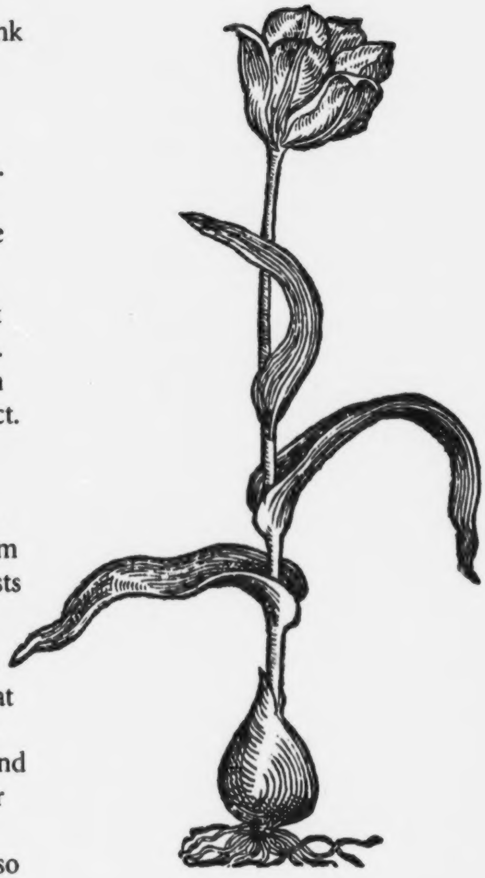
After the kids have made some predictions, try the following demonstration to get them thinking about some of the other changes that can occur when parts of a forest are cut down. (This demonstration works best with a group of at least 20 kids.)

CHOPPING DOWN THE FOREST

Have the kids stand close together in a big group in an open area of the room. Tell them that each one of them is a tree, and together they represent a huge tract of undisturbed tropical rain forest. Have one child in the center of the forest describe what he or she sees when looking "through the trees." Can he or she see the forest edge? you? the rest of the room? Is there much light down near the floor? (Point out that, in many tropical rain forests, the canopy is so thick that little sunlight reaches the forest floor.) Then turn a small electric fan on low at the edge of the forest and ask the center child if he or she can feel a breeze.

Now "chop down" part of the forest by having some of the kids near the edge move aside. (Pick kids from each "side" of the edge.) Ask the center child to report any changes in what he or she can see. Turn the fan on low again, and ask if the center child can feel a breeze. Once part of the forest has been cut down, the center child should notice more light near the floor, should find it easier to see through the trees to the edge of the forest, and should be able to feel a much stronger breeze. If none of these changes occur, chop down some more of the trees at the edge.

After the demonstration, ask the kids what has happened to the area that used to be the middle of the forest. (It's now at or near the forest's edge.) Then ask them how this shift from forest middle to forest edge might affect the life within the forest. Point out that many of the plants and animals that were adapted to living in the middle of the forest might not be able to survive at the forest edge. Can the kids think of reasons for this? (Changes in temperature, moisture level, air circulation, and so on would occur at the forest's new edge. For example, the former "middle of the forest" would now receive much more sunlight than before, raising the overall temperature of the area. The area would also receive more wind, which could make the new edge drier than when it was part of the forest's middle.) Again, list the kids' answers on the chalkboard or a piece of easel paper.



Now tell the kids that some scientists in Brazil are studying what happens to the life in a rain forest when part of the forest is cut down. Then, using the information under "What's Happening in Brazil?" on page 404, explain the Biological Dynamics of Forest Fragments Project. Make sure the kids understand that the forest in the area where the scientists are working was going to be cut down anyway. But by directing where the loggers cut, the scientists have been able to create reserves, or forest "islands," of specific sizes. Show the kids the diagram you copied earlier to give them a better idea of what it is these scientists are doing.

Also explain that the scientists are trying to figure out how big a reserve might have to be in order to protect as many of the species that live in a rain forest as possible. For example, could most of the plants and most of the birds, mammals, amphibians, and other animals found in the Brazilian rain forest survive in a 2500-acre (1000-ha) reserve or would it take a 25,000-acre (10,000-ha) reserve? Or one that's even larger? (Note: Explain that new research shows that some species are so specialized that they may become extinct if even a small area in certain parts of a rain forest is destroyed.)

Afterward pass out copies of the charts and graphs so the kids can see some of the things that have happened in the isolated reserves of the Forest Fragments Project. Explain that the charts and graphs show real data that the scientists have collected from 2.5-acre (1-ha) and 25-acre (10-ha) reserves during the reserves' first two years of isolation. Then pass out copies of page 407 and have the kids answer the questions using the charts and graphs.

When the kids are finished, ask them if any of the changes they predicted earlier occurred in the reserves the scientists studied. Talk about the changes, then go over the answers to the questions (see the end of this activity). As you go over the answers, discuss the fact that all animals and plants depend on specific physical conditions in their habitats in order to survive. For example, when light conditions changed in the forest areas the scientists were studying, many of the butterfly species that had lived in the forest's interior disappeared. And trees that were once in the interior were damaged and even knocked over by increased wind.

Also point out that all animals and plants depend on other species in order to survive and reproduce. For example, monkeys that eat fruit were absent or very rare in the reserves because many of the fruit trees they depended on had been chopped down. (There were still some fruit trees left, but not enough to support the monkeys year round.)

You might also want to explain that animals need a certain amount of space in order to find all the food and water they need to survive. For example, herds of white-lipped peccaries need thousands of acres. (For more about how much space certain animals need, see "A Home in the Range" on pages 43-45 of *NatureScope: Amazing Mammals—Part I.*)

Finally, ask the kids if they think either the 2.5- or 25-acre (1- or 10-ha) reserve would be large enough to preserve the variety of life found in the Brazilian rain forest the scientists are studying. Tell them that even though the Forest Fragments Project is far from over, scientists are predicting that a Brazilian rain forest reserve would probably have to cover millions of acres in order to protect most of the species that live there.

WHAT'S HAPPENING IN BRAZIL?

In 1977, Dr. Thomas Lovejoy of World Wildlife Fund (WWF) was looking for a place to try an experiment. He wanted to find out what happens when a tropical rain forest is separated by roads, pastures, and other human developments. He also wanted to try to find out how much forest it might take to make a reserve large enough to support the plants and animals that normally live in a rain forest.

Lovejoy knew that, under Brazilian law, any land development project in the Amazon region of Brazil must leave half of the area forested. He discovered some land that was going to be converted to pasture and asked if he could direct which parts of the total area would be converted to pasture and which ones would be left undisturbed. The local government, Brazilian scientists, and the ranchers agreed to cooperate.

In 1979, scientists from WWF and Brazil's National Institute for Amazon Research began mapping out more than 20 areas within the virgin rain forest. These areas would eventually become reserves of varying sizes: 2.5, 250, and 2500 acres (1, 10, 100, 1000 ha). There was also one 25,000-acre (10,000-ha) reserve. Then, with help from more scientists and some of the ranchers, they obtained a "before" picture of each future reserve by taking an inventory of the plants and animals in each one.

Finally, in 1980, the ranchers started cutting down the forest. The reserves, once part of a continuous forest, became isolated "islands" of trees. And the scientists immediately started monitoring the changes that occurred in each "island." So far only 10 of the reserves have been isolated or separated from the continuous forest. The scientists are planning to continue the experiment until at least 1999.

BRANCHING OUT: MEASURING THE DIFFERENCE

Temperature variation between the edge of a forest and its interior occurs in all forests—not just in tropical rain forests. To help your kids see how temperatures vary between the inside and outside of a forest, take them to a nearby woodlot and have them measure the temperature at the edge of the woods, just inside the woods, and 50 feet (15m) or more into the woods.

You can also measure differences in evaporation rate and soil moisture. To get an idea of differences in evaporation rate, hang one wet cloth inside the forest and one outside and see how long it takes each to dry. And to determine soil moisture differences you can just feel the soil both inside and outside the forest. (In general, soil in a forest holds more moisture than that outside a forest.) After taking your measurements, discuss the fact that many of the animals and plants that are adapted to conditions within a forest often can't survive outside a forest, even at its edge.

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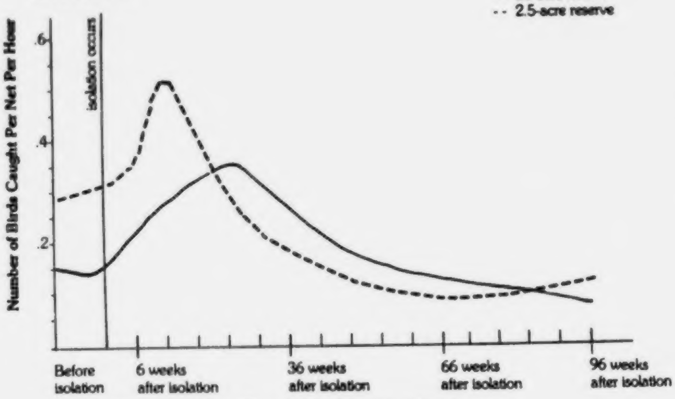
SIZING UP RESERVES (A)

GRAPH 1



Note: There were a total of 16 nets. The graph shows the average number of birds caught per net per hour.

GRAPH 2

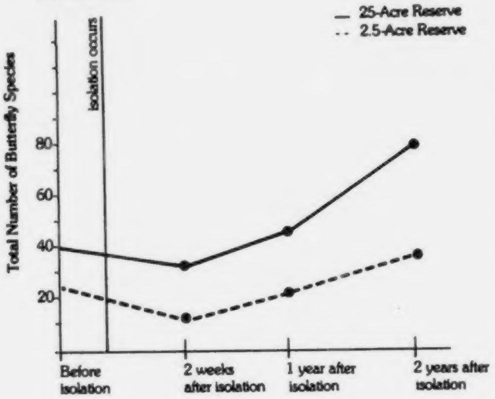


TABLE 1

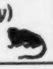
Mammal	Continuous Forest	25-Acre Reserve	2.5-Acre Reserve
Red howler monkey	very abundant	very abundant	absent
White-faced saki (monkey)	rare	absent	absent
Golden-handed tamarin (monkey) 	abundant	absent	absent
Collared peccary (piglike mammal)	abundant	absent	absent
Acouchi (large rodent)	very abundant	rare	absent
Paca (large rodent)	abundant	absent	absent
Rice rat	rare	rare	rare
Nine-banded armadillo	very abundant	rare	absent

TABLE 2

Death Rates of Trees 2 Years After Isolation	
2.5-acre reserve	2.6%
25-acre reserve	2.6%
continuous forest	1.5%

The 2.5- and 25-acre reserves were hotter and drier than the continuous forest. And temperatures between the edges and 300 feet within one 250-acre reserve varied by as much as 8° F.

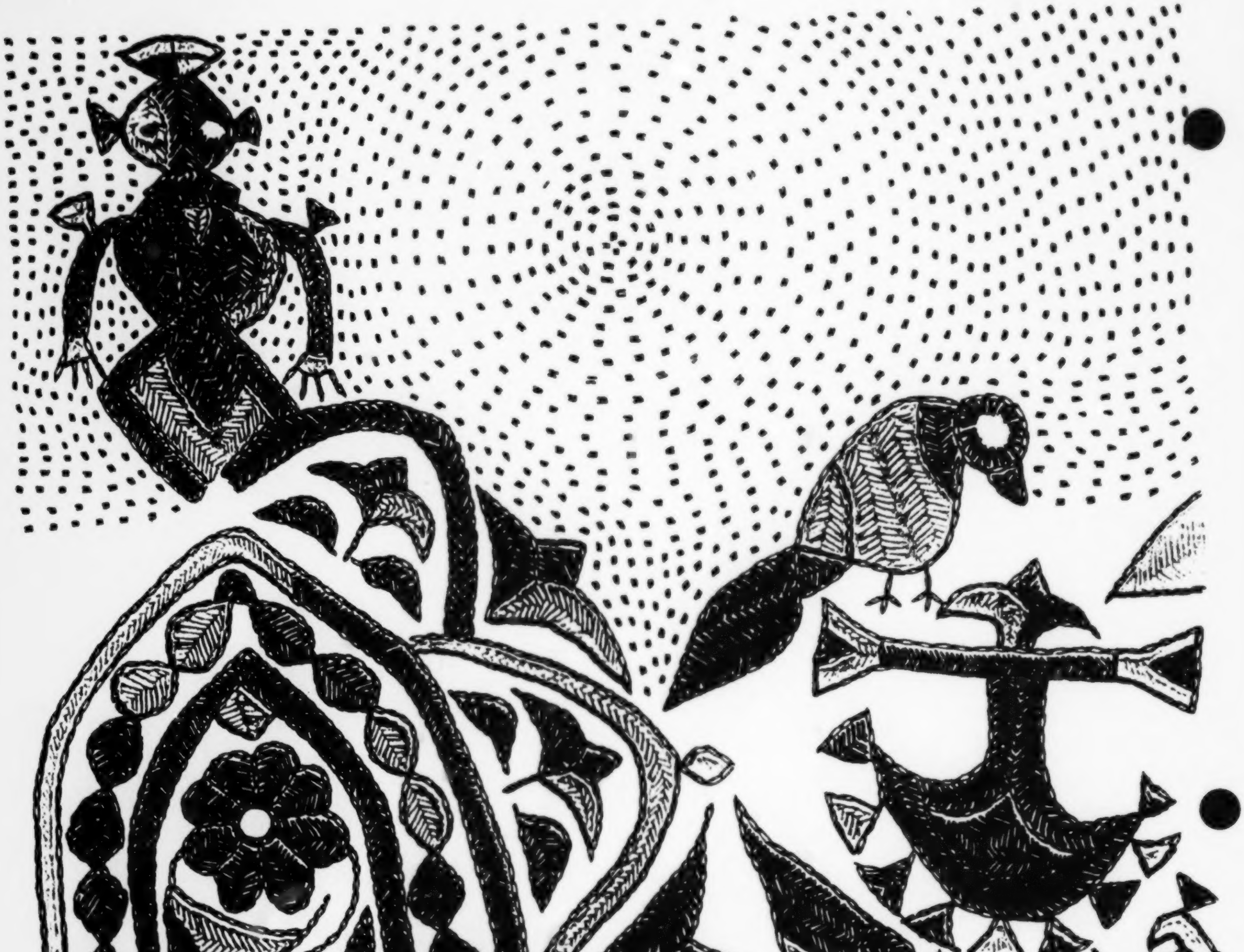
1. **Which of the following statements best describes what happened to the *number of birds caught per net per hour* in the reserves?**
   a. The number nearly doubled just after the reserves were isolated and then dropped dramatically. After 96 weeks the number was lower than before the reserves were isolated.
   b. The number slowly increased in the reserves after the reserves were isolated and kept increasing for 96 weeks.
   c. The number remained unchanged.

2. **Which of the following statements best describes the second graph?**
   a. The number of butterfly species decreased steadily for two years after the reserves were isolated.
   b. Immediately after the reserves were isolated, the number of butterfly species dropped. But after two years the number was the same as before isolation.
   c. Immediately after the reserves were isolated, the number of butterfly species dropped. But after two years there were more kinds of butterflies than before isolation.

3. **Which of the following statements best describes the information in Table 1?**
   a. Most of the mammals present in the continuous forest were just as common in the reserves.
   b. Most of the mammals present in the continuous forest were absent from the reserves.
   c. Most of the mammals were rare in both the reserves and the continuous forest.

4. **Look at the information in Table 2. Did a greater percentage of trees die in the reserves or in the continuous forest?**

5. **After three years, no barred leaf frogs were found within the 25- or 2.5-acre reserves. Several other kinds of leaf frogs had disappeared as well, even though other kinds of frogs were still found in the reserves. Given the following information, why do you think the barred leaf frogs disappeared?**
   - Barred leaf frogs lay their eggs in puddles.
   - White-lipped peccaries are piglike mammals that live in herds. These herds need thousands of acres of undisturbed forest in order to find all the food they need to survive.
   - When white-lipped peccaries wallow in the mud they create small puddles.



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25.

Science/Technology/Society

> *We shall require a substantially new manner of thinking if [people are] to survive.*
>
> —Albert Einstein

From genetically engineered microbes to nuclear energy to supersonic flight, technology has changed the world. We can now tinker with the weather, fax information around the world, and get a new heart. But what are the trade-offs associated with new technology? Is nuclear power the answer to our energy shortages? Are pesticides and large scale farming the answer to the world's hunger problem? Many of the technological advances we've achieved have a price tag, and our students will be the ones that have to deal with the choices we make today.

In many parts of the world, there is a growing movement to help students understand the connection between science and technology. In some areas, this emphasis is dubbed *STS—Science, Technology, and Society.* In other areas, it's called *STE—Science, Technology, and the Environment.* Regardless of the acronym, the connection between science and technology is an important and integral part of environmental education. Every technological advance has an environmental consequence—from using scarce resources to polluting ecosystems, and it's important for students to see that connection. It's also important that students understand that all decisions involve trade-offs. By incorporating activities that focus on the connections between science, technology, and the environment, you can help students understand the complex problems they will be facing in the future and help them learn how to make effective and just decisions.

We've included two activities in this section. The first looks at the advantages and disadvantages of current technologies. And the second looks at issues involving genetic engineering.

Activities in this Section

1. **Challenge Technology**, reprinted with permission from *Ranger Rick's NatureScope: Pollution—Problems and Solutions* published by the National Wildlife Federation (1990).
2. **The "Good" Bacteria Controversy** excerpt reprinted with permission from *Decisions for Today and Tomorrow—Genetic Engineering* by Louis A. Iozzi, Cook College, Rutgers University, New Brunswick, N.J., and Peter J. Bastardo, Highland Park Public Schools, Highland Park, N.J. (1987, 2nd edition 1990).

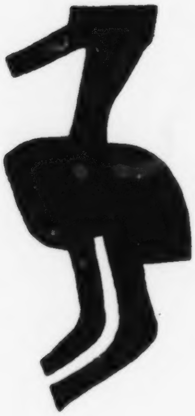
CHALLENGE TECHNOLOGY

OBJECTIVES:
Define technology. Describe some advantages and disadvantages of current technologies. Identify some careers associated with pollution prevention and cleanup.

AGES:
Intermediate

SUBJECTS:
Science, social studies, art

MATERIALS:
Copies of page 412; copies of the challenges on pages 413 and 414, drawing paper; crayons or markers



Here's an activity that will encourage your kids to think about the advantages and disadvantages of some of today's technologies. Begin by asking the kids to explain what the word "technology" means. Discuss their ideas, and then explain that technology is the application of science to solve problems. Have the kids come up with some examples of modern technologies. (cars, power plants, genetic engineering, computers, and so on) Point out that although technological advances have helped make life easier in many ways, they've also introduced new problems. For example, cars provide people with personal freedom, and they've made it possible to travel long distances in relatively short periods of time. But cars create problems too. Ask the kids if they can describe some problems associated with cars. (cause air pollution; result in human death and injury; require the building of roads, which destroys habitats; and so on)

Then explain that people are just discovering how some of the technologies we've created can harm the environment. For example, many scientists believe that acid rain, caused by pollutants released from coal-burning power plants and motor vehicles, is affecting the health of forests and lakes in some areas.

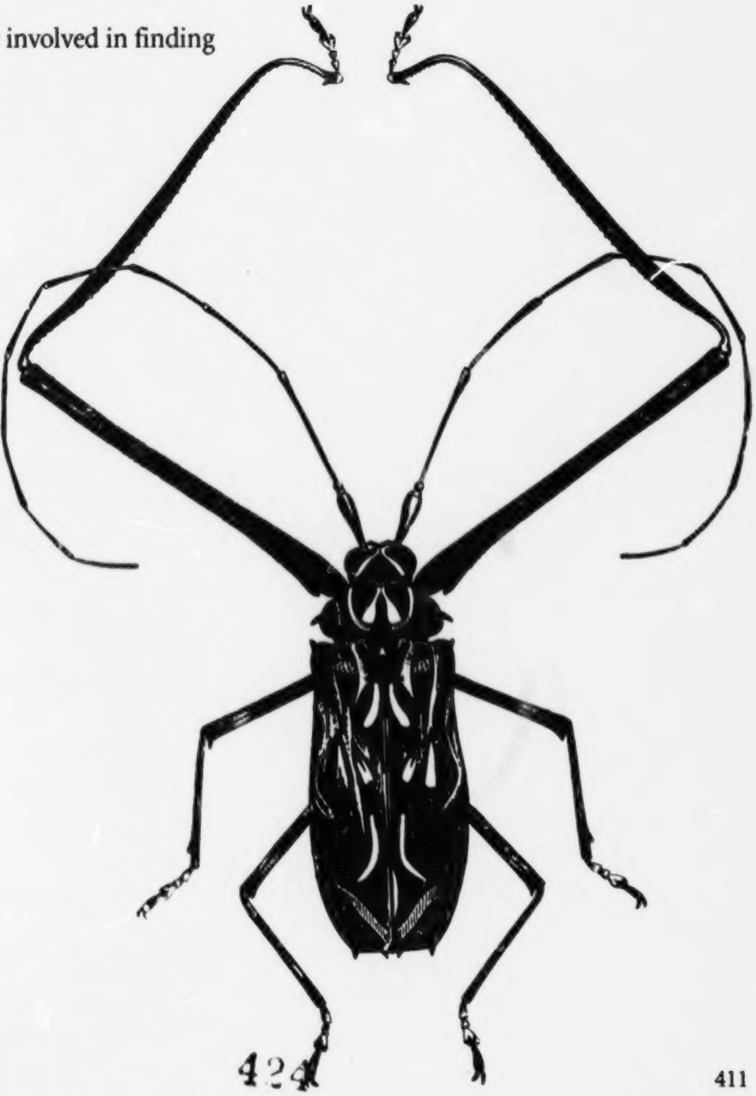
Tell the kids that some people are working to improve existing technologies and to develop new technologies that can help solve some of our environmental problems. Explain that the kids will be getting a chance to invent their own pollution-solving technologies. Give each person a copy of the "Technology Challenges" on pages 413 and 414. Explain that the information describes some problems associated with different forms of technology that we use today. Then divide the group into six teams and assign each team one of the challenges.

Have the kids in each team read about their technology and then brainstorm some ideas to address their challenge. The ideas they come up with can include improvements on the current technology, or they can be entirely new types of technology. Emphasize that there are no right or wrong answers to the challenges and encourage the kids to think as creatively as possible. Also have the kids illustrate their solutions and write down a few sentences that explain how they work.

When everyone has finished, have each team present its solutions to the rest of the group. Encourage the kids in the audience to ask questions and offer comments after each presentation. If the kids come up with a new kind of technology, discuss how it might introduce new pollution problems. Also have the kids consider other solutions to their challenge. For example, instead of making new types of cars that don't pollute as much, it might be better to design a city where people don't have to travel so far every day.

Next pass out a copy of page 412 to each person, and have them read about some real solutions to existing pollution problems. Have them think about the advantages and disadvantages of each one. Then discuss these questions with the group:

- Do you think we can rely on new technologies to solve all our pollution problems? Why or why not? (Answers will vary. Point out that new technologies often introduce new pollution problems and, in some cases, act as "Band-aids" to temporarily deal with problems without addressing the real solutions.)
- Are there ways to solve pollution problems without developing new technologies? (Yes. People can change their behaviors. For example, people can cut down on the amount they drive by using public transportation or by riding their bikes more often.)
- Do you think we really need all the technologies we have? Why or why not? (answers will vary)
- What kinds of professions might be involved in finding solutions to pollution?



Pollution-Fighting Technologies

Super Bulbs: Energy-efficient, compact fluorescent bulbs use one quarter of the energy of standard incandescent bulbs, and they last up to 10 times longer. By decreasing the demand for electricity, these bulbs can help reduce air pollution. But compact fluorescent bulbs are more expensive than incandescent bulbs, and they come only in lower wattages.

Goop Gobblers: Scientists have discovered strains of bacteria that feed on oil and other toxic pollutants. Bacteria have been used to clean up chemical spills and agricultural runoff. But sometimes the bacteria work too slowly—or not at all. And some scientists are concerned that introducing bacteria into areas where they aren't naturally found may disrupt local ecosystems.

Philodendron Filters: Scientists have discovered that common household plants such as *Philodendrons*, spider plants, and gerbera daisies can absorb some indoor air pollutants.

Bug-Vac: In California, some strawberry growers are experimenting with a safer alternative to pesticides. By attaching a giant vacuum, called a "Bug-Vac," to their tractors, they can suck bugs off their crops without damaging the fruit—and without using pesticides that can poison other animals and contaminate water supplies. But the Bug-Vac also removes some insects that don't harm crops.

Wave Catchers: A floating device called the "SEA Clam" captures wave energy in the sea. Waves press against SEA Clam's air bags, squeezing air through a valve and into a chamber where it spins a turbine that generates electricity. The SEA Clam equipment is expensive and can be used only in areas that have suitable waves.

Wacky Windmills: Modern windmills have been specially designed to efficiently catch the wind and use it to produce electricity. Wind-generated electricity doesn't create air pollution, but it's sometimes more expensive and less reliable than electricity produced by burning fossil fuels. (New turbine designs and blade shapes may make them more efficient in the future.) Some people complain that windmills ruin scenic areas.

Sun-Mobiles: Instead of burning gasoline and polluting the air, solar-powered cars capture and use the energy from sunlight. Solar cells mounted on the cars turn this energy into electricity. On cloudy days, drivers keep their cars going by using extra energy from sunnier days that's stored in the car's battery. Currently, solar cars are expensive to manufacture and don't go as fast as gasoline-powered cars.

Smoke Scrubbers: In some coal-burning power plants, machines called *wet scrubbers* spray lime and water into smoke entering the smokestacks, rinsing out sulfur dioxide (a pollutant that causes acid rain) before it leaves the smokestack. This keeps most of the sulfur dioxide from getting into the air, but can leave a toxic sludge that must be disposed of.

TECHNOLOGY CHALLENGES

1. TOXIC ROADS

During the winter, snow and ice can build up on roads, making it dangerous for people to drive. Snow-plowing removes only some of the snow and ice, so a special kind of salt is also spread on many of the roads to melt the rest. But when the snow and ice melt, the salty water runs off into lakes, rivers, streams, and other waterways. This salty runoff can kill fish and other animals, affect the growth of plants, and contaminate drinking water.

YOUR CHALLENGE: Invent a better way to make roads safe for travel during snowy winters.

2. TRAFFIC TROUBLES

In many cities, cars are the major means of transportation. They're also one of the major causes of air pollution. With so many people driving their cars every day, there's a lot of air pollution created by the cars while they're stuck in traffic.

YOUR CHALLENGE: Invent a better form of transportation.

3. PESTY POISONS

Many farmers use pesticides to kill insects that damage their crops. Unfortunately, these pesticides often harm birds and other animals. Pesticides also contaminate water supplies.

YOUR CHALLENGE: Invent a better way to control pests.

4. OVERDOING IT

To keep fruit from being damaged during shipping, it's often placed on plastic foam trays and then wrapped in more plastic. But when the plastic is thrown away, it ends up in landfills that are already overflowing with garbage. And many toxic by-products are created when plastic is manufactured.

YOUR CHALLENGE: Invent a better way to package fruit to keep it from being damaged during shipping.

5. DON'T BE FUEL-ISH

Many power plants burn coal or oil to produce electricity. But burning these fuels results in air pollution. And getting these fuels out of the ground damages wildlife habitat. Natural areas can also be affected by accidents that occur when oil is being transported.

YOUR CHALLENGE: Come up with a less-polluting way to create energy.

6. DANGER INDOORS

In an effort to cut down on the energy needed to heat and cool buildings, many modern buildings have been designed to be as airtight as possible. But many pollutants can accumulate inside these "closed" buildings. (These pollutants are released by sources such as copy machines, cigarette smoke, new furniture, and cleaning chemicals.) In fact, the air pollution inside some buildings is much worse than it is outside! This indoor air pollution has made some workers sick.

YOUR CHALLENGE: Invent a way to reduce indoor air pollution without increasing the amount of energy used to heat and cool a building.

ADDITIONAL CHALLENGES (DEVELOPED FOR THE SOUTH PACIFIC)

1. PESTY POISONS

Many farmers use pesticides to kill insects that damage their crops. Unfortunately, these pesticides often harm birds and other animals. Pesticides also contaminate water supplies.

YOUR CHALLENGE: Invent a safer way to control crop-eating insects.

2. FISH KILLS

Many people use explosives and poisons to catch reef fish. In many cases, more fish are killed than needed. And in most areas, many reef animals are also killed by the explosives and poison.

YOUR CHALLENGE: Invent a safer way to fish.

3. LIVESTOCK DAMAGE

Livestock, such as sheep, goats, and pigs, have been introduced to many tropical islands. The livestock roam the steep hillsides, eating much of the vegetation and loosening the soil with their hooves. Heavy rains wash the soils and manure from the denuded land into rivers and other bodies of water. The manure and silt pollute fragile aquatic habitats where young fish and other marine and freshwater creatures grow up. As a result, the number of fish in some areas has decreased.

YOUR CHALLENGE: Invent ways to avoid the siltation and pollution caused by livestock.

4. TRAFFIC TROUBLES

In many cities around the world, cars are the major means of transportation. They're also one of the major causes of air pollution. With so many people driving their cars every day, there's a lot of traffic. A great deal of air pollution is created by cars while they're stuck in traffic.

YOUR CHALLENGE: Invent a better form of transportation that's appropriate for your area.

5. CRUSHING CORALS

Coral reefs are a favorite place for scuba divers, snorkelers, sailors, and people who fish. All of these people take boats across the water and drop anchor above the reef. But these anchors often damage the coral, particularly when they've been set improperly, so that they drag along the sea bottom as the boat drifts. In some popular scuba and fishing spots, damage from anchors has become a significant threat to the beauty and survival of the coral reefs.

YOUR CHALLENGE: Invent a way to decrease the damage from small ships anchoring at a coral reef.

6. OVER-PACKAGING

Bongos are tasty snack foods that are packaged in handy, single-sized servings. But once the snacks are eaten, people toss the plastic wrappers away. Most of the wrappers end up in dumps that are already overflowing. And many toxic by-products are created when plastic is manufactured or burned.

YOUR CHALLENGE: Invent a better way to package Bongos and other snack foods.

7. GHOST FISHING

Nets made of plastic are causing problems for marine animals. Unlike nets made of cotton, manila rope, or other natural fibers that disintegrate in a matter of months, plastic nets are very durable and can last for years and years.

That makes net mending less of a chore for fishers. But it has caused another big problem: ghost fishing. Nets and fishing line are frequently lost when people fish or travel. After a plastic net is lost, it can continue trapping fish—for years. "Ghost fishing" nets can trap seals, sea lions, dolphins, seabirds, and fish. One mile-wide ghost fishing net found in the North Pacific had trapped 99 seabirds that had tried to eat the fish already snared in the net.

YOUR CHALLENGE: Invent a way to fish efficiently without contributing to the ghost fishing problem.

THE "GOOD" BACTERIA CONTROVERSY

OBJECTIVE:
Read and discuss different views about specially engineered bacteria.

AGES:
Intermediate

SUBJECTS:
Social studies, ethics

MATERIALS:
Copies of information and questions

Two scientists at the University of California at Berkeley received permission from the NIH (National Institute of Health) advisory committee to perform a rather simple test using specially engineered bacteria, *Pseudomonas syringae. Pseudomonas* live as parasites in the leaves of many plants. When the temperature falls to freezing (0°C), these bacteria produce a protein upon which ice crystals can form. The frost damages the plant, then the bacteria feed on the frost-damaged tissues. Plants free of *Pseudomonas* can, for brief periods, withstand temperatures as low as -15°C before being harmed.

The two scientists, Steven Lindow and Nickolas Panopoulos, produced *Pseudomonas* without the gene that codes for the "culprit" protein. They intended to spray them on crops in sufficient quantity to drive out the normal bacteria. This would prevent crop losses in the event of unseasonal frosts. It would also extend the growing season and increase production.

The scientists had used these techniques very successfully in greenhouse experiments. They wanted to spray an agricultural field to determine if their technique would really work.

One citizen, Jeremy Rifkin, thought that releasing organisms altered by gene splicing could endanger public health and the environment. He campaigned against all recombinant DNA research. He equated such research with Nazi eugenics. He was aware of the medical and scientific gains attributed to DNA research, but he remained totally against it.

In 1977, Rifkin sought an injunction against the Berkeley researchers to prohibit them from releasing the bacteria. Much to the surprise of the scientists, shock might be a better word, Judge John J. Sirica complied with Rifkin's request. Sirica also directed the NIH not to consider proposals for experiments involving the release of engineered organisms into the environment.

Judge Sirica raised two significant questions during the proceedings:

Did the NIH, in granting permission to Lindow and Panopoulos to conduct the experiment, assess the risks involved as required by federal laws?

Should society (that is, the courts), rather than the scientific community, regulate the growing field of biotechnology?

Until now, the NIH advisory committee had been the sole judge on any issues dealing with gene splicing experiments funded by the government. Private companies did not have to go through this committee. However, many companies did voluntarily seek clearance from the committee.

In making his judgement, what did Judge Sirica imply about the job done by NIH's DNA advisory committee?

From your reading, how well do you think the DNA advisory committee had performed? Explain your answer.

During the hearing, both sides tried to get the judge to listen to expert testimony. Judge Sirica refused, maintaining that he was not there to judge science but to determine whether the NIH had followed required procedures. That is, did the NIH, as Rifkin charged, violate the National Environmental Policy Act (NEPA). NEPA requires federal officials to file environmental impact statements before approving "action significantly affecting the quality of the human environment."

Some scientists, while not pleased with the ruling, felt that the hearing had raised some significant issues. The following are observations from scientific experts:

"There is an appropriate time and place for public debate on the introduction of genetic engineering techniques in our society. However, by vastly exaggerating the possibility of a genetic catastrophe, Rifkin obscured any legitimate concerns the public may have."

—Frederick Ausubel, Genetics Professor, Harvard Medical School

"To agree that is a new life-form (Lindow and Panopoulos' genetically engineered Pseudomonas*) and is capable of upsetting a delicate ecological balance is to suggest that two individuals who differ in an eye color gene are different life-forms, or that an individual who is treated with a drug to protect against the action of a deleterious gene product will upset nature's good design."*

—Paul Berg, Geneticist, Stanford University, Nobel Prize
winner for pioneering work in recombinant DNA

"Recombinant DNA technology is a tool, no more moral or immoral than electricity, fire, or the hammer. Let's not allow misguided fears to deny its benefits to ourselves and posterity."

—Harold Slavkin, Biochemist, University of Southern California

"The release of gene-spliced microorganisms into the environment at this stage, before any type of assessment has been made, would be totally irresponsible."

—Liebe Cavalieri, Biochemist, Sloan-Kettering Institute

"...The historical record shows severe problems have resulted when alien species have been imported into the United States. The Japanese beetle and gypsy moth have caused great problems. Genetically-engineered organisms could do the same...altered bacteria could get into the atmosphere and eventually change the climate by retarding the formation of ice crystals."

—David Pimentel, Ecologist, Cornell University

"I continue to believe that the factors need to be considered carefully, but if I were a member of the RAC (Recombinant DNA Advisory Committee), I would vote to allow these experiments to proceed."

—Peter Raven, Botanist, Washington University, St. Louis

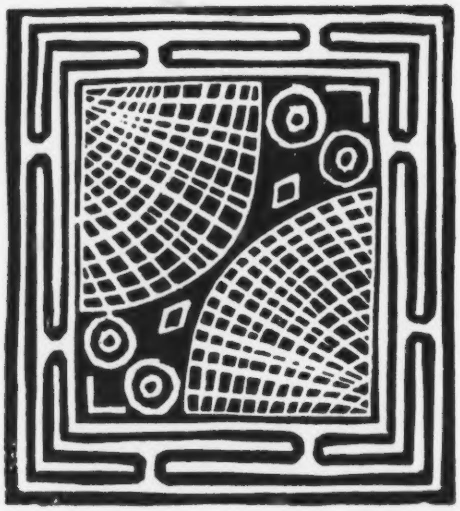
The approved test not only presents no threat to the environment, but the approach to be used is environmentally one of the least disruptive known for the protection of plants against harmful organisms.

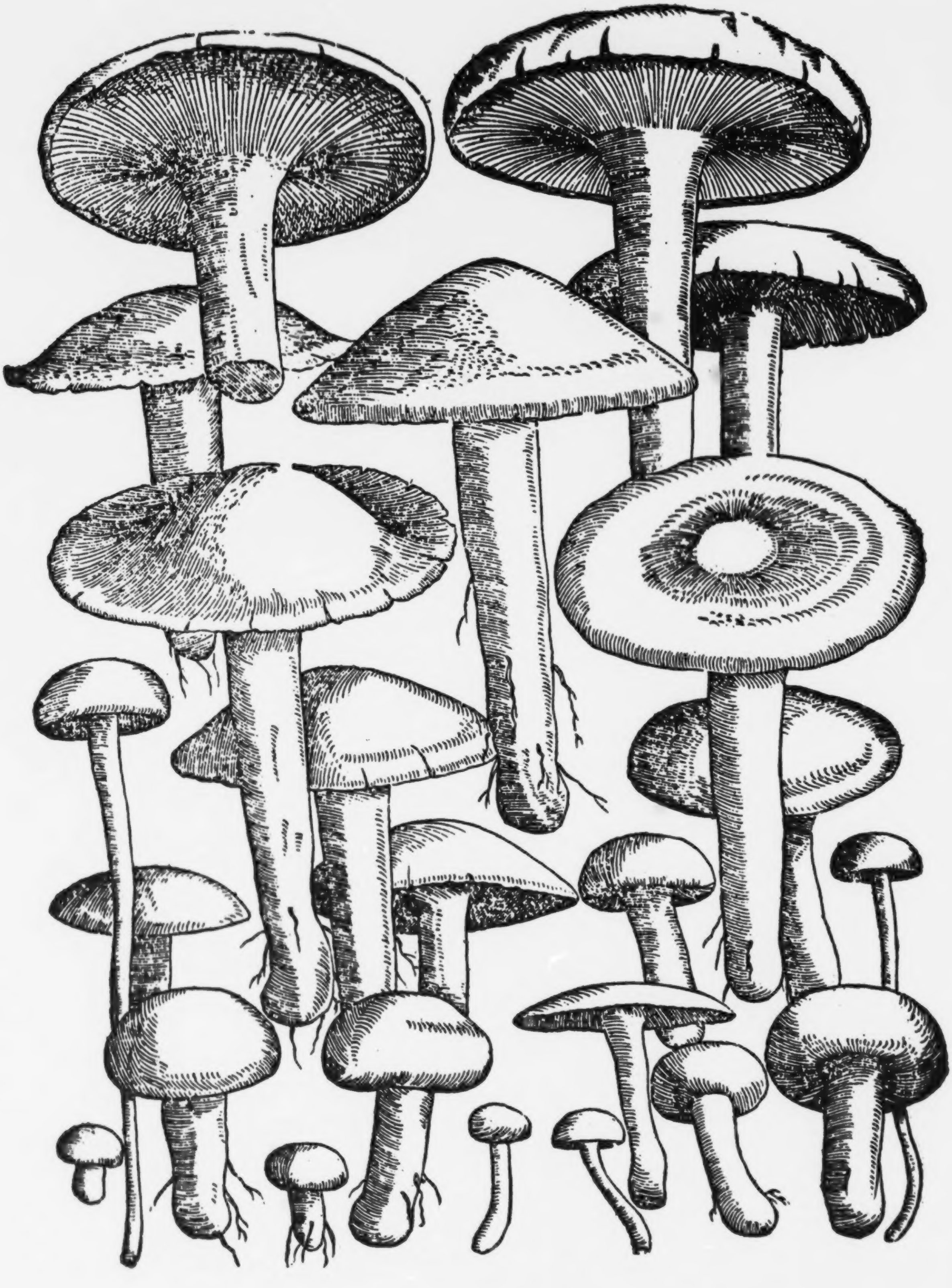
—James Cook, Plant Pathologist, U.S. Department of Agriculture

With which statements do you agree?

With which do you think Judge Sirica would agree?

Judge Sirica ruled against genetic engineering research. Do you agree with him?





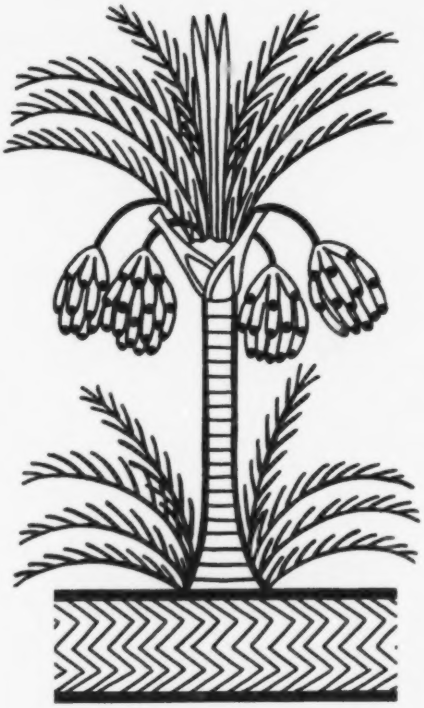
TAKING ACTION FOR THE PLANET

26.

Environmental education action projects stress community-based learning and give students an opportunity to participate as active citizens in helping to tackle an environmental or social issue. By taking part in an action project, students can act on their value decisions about the environment and work to improve environmental conditions. Action projects help students gain knowledge about local environmental issues, as well as gain social skills, such as group cooperation and political participation. Here are some examples of the projects students around the world have taken on:

> *Don't ever let anyone tell you that one person cannot make a difference!*
>
> —A Returned Peace Corps Volunteer from Nepal

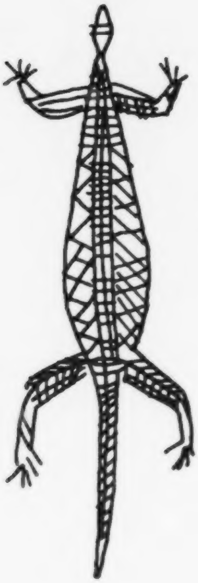
- implementing water-saving strategies at home and school
- writing letters to elected officials
- forming litter patrols
- writing letters to newspapers and magazines
- writing letters to business leaders
- sponsoring recycling drives
- joining and supporting NGOs working for clean air, clean water, and habitat protection
- making displays for libraries and schools
- encouraging mass transit instead of driving
- sponsoring hazardous waste community clean-ups
- advertising oil recycling centers
- using IPM (Integrated Pest Management) strategies to grow vegetables
- preparing information booklets about toxic chemicals for consumers
- teaching literacy using environmental content
- sponsoring debates on waste issues
- making exhibits for zoos and museums
- planting trees and taking care of urban trees
- adopting streams, rivers, lakes, ponds, highways, and forests
- monitoring water quality and sharing the data
- sponsoring river, lake, stream, and coastal clean-ups
- sponsoring award programs recognizing the positive things people do to help the environment



> *There isn't a government in the world that would have done anything for the environment if it weren't for the citizen groups.*
>
> —Konrad von Moltke

It makes sense that taking part in community-based action projects might encourage students to be more environmentally conscious and active citizens—especially if the experience is positive. Another way to give students practice in solving environmental problems through action that takes up less time and resources is using case studies of action projects. By discussing what went right and what didn't, students can learn many skills for getting involved in future environmental action projects.

In some areas, it might be difficult to take on a full-scale community action project. It's always important to check with school administrators, colleagues, parents, and other key people before getting students involved in a major community-based project. It's also important to get buy-in from these key people to make the program successful.



Action projects can be as simple as writing a letter to members of the government or as involved as setting up an ongoing recycling program in your community. What's important to remember is that the most successful projects are those identified and initiated by the students themselves, and those that involve community leaders and parents. Use these general guidelines to map out your own strategy for taking action.

INVESTIGATE THE ISSUES

Before starting any project, your group will probably need to conduct research to find out more about environmental problems in general and, more specifically, about local problems. Have your group generate their own list of research projects, using information from class and their own knowledge of local and national environmental problems.

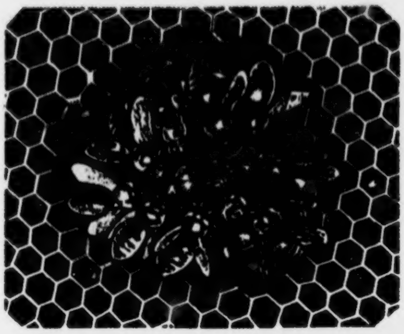
It's important for the students to get into the community to experience local issues by observing, interviewing, and developing a feeling for the problems. For example, it's much more effective if the kids visit a landfill, rather than reading about it or making a phone call to find out about it.

DEFINE THE PROBLEM

After researching environmental issues, make a list of the problems and discuss how the group feels about taking action to help solve any of them. Generate some criteria that can help the group decide which problem to tackle. For example, does the problem interest the group? How serious is the problem and what is the scope of the problem? Who is causing the problem and why are they causing it? Does the problem directly affect your community? Does it directly affect the students? What is the ultimate goal in tackling the problem? What's the first step in achieving that goal? What is the chance for success or partial success? By answering questions like these, your group can help select and define the problem they want to work on.

BRAINSTORM SOLUTIONS

Once the group chooses a problem to work on, discuss possible projects that will help solve the problem. (This might take additional research.) Make a list of the pros and cons of each project, keeping in mind the available resources you have, including people, time, money, transportation, and so on. Have the kids select the most feasible project before starting that next step—developing a plan of action.



DEVELOP AN ACTION PLAN

To help come up with a plan of action, encourage the group to discuss some of the following questions. (You can do this with the entire group, or have the students work in teams.)

- Who in the community can help? (for example, university professors, government officials, parents, and so on)
- Who in the community can help provide different points of view on the problem?
- Who else in the community should be informed about the project?
- What materials and resources are needed and where will they come from?
- How much time will the project take?
- How many people will need to help?
- Does any further research need to be done?
- What needs to happen for the project to be successful?
- How will the project be evaluated?

Then have the students complete a step-by-step plan that includes goals and objectives for the project, as well as a general time line. Explain that the plan they develop should be revised and adjusted throughout the project to reflect new information or feedback.

FINALIZE THE ACTION PLAN

Evaluate the plan of action and set up checkpoints along the way to ensure that progress is made once a project starts. (If the students are working in teams, have each team evaluate the plan.) Incorporate suggestions about how to improve the plan, and make sure it's clear who is responsible for each step. Also discuss the importance of keeping a positive attitude and staying flexible while the plan is being carried out.

IMPLEMENT THE PLAN

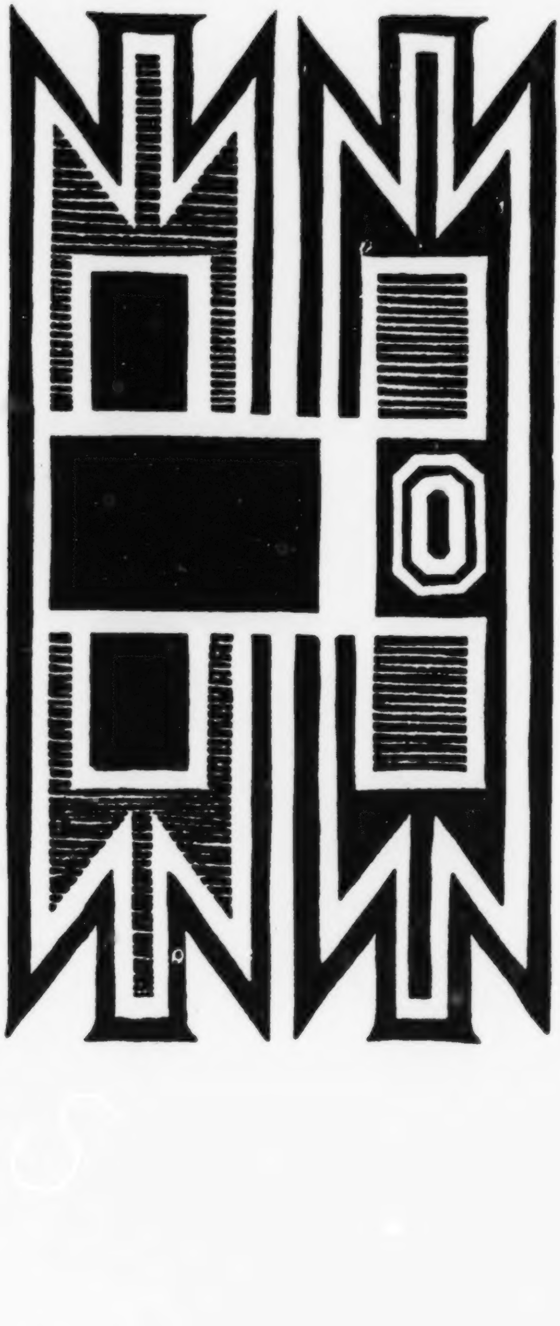
As you carry out the action plan, encourage the students to keep records of what they do, whom they contact, and what they accomplish. You can also suggest that they keep personal journals to record how they feel about the project. For example, they might want to write about how they felt during successes or setbacks. And throughout the project, make sure everyone in the group feels that he or she is really contributing to the solution.

Also invite local media representatives to speak to the group about how to get publicity for the project. By getting local newspapers and TV and radio stations to publicize their activities, the students will reach more people with their message. And they'll learn how to use the media to educate others and influence behavior.

EVALUATE THE PROJECT

After the project is completed, have the students evaluate it. For example, ask them:

- What did you accomplish? What has changed since the project started?
- What did you feel was the most successful part of the project? What was the most disappointing?
- What would you have done differently?
- What did other people involved in the project think about it?
- Would you get involved in another similar project? Why or why not?
- Do you feel that students can make a difference?



ENVIRONMENTAL CAMP IS A HIT WITH STREET KIDS

In an effort to help street kids living in urban areas in Costa Rica, four Peace Corps Volunteers, along with a WorldTeach Volunteer, developed a challenging summer program. The project, called "What Planet Are You From?", is aimed at physically and mentally challenged children at risk. Through a series of outings to various national parks, reserves, and farms throughout Costa Rica, the children get a chance to explore a new environment, gain self esteem, and improve communication skills. And by having a chance to get out of their normal surroundings and climb a mountain, cross a river, or explore a volcano, they are able to learn more about the natural history and beauty of their country while at the same time feeling good about themselves.

8

MAKING AN ENVIRONMENTAL EDUCATION PROGRAM WORK

> *The monkey learns to jump by trying again and again.*
>
> —West African Proverb

Janell had spent more than two months setting up a special environmental education curriculum writing workshop for the teachers in her area. She and four other educators, three from local schools and one from the Ministry of Education, had worked together for several months to develop a curriculum outline. Now they wanted to develop activities to help teach the concepts that they had outlined. Instead of starting from scratch, Janell gathered as many existing materials as she could from the Ministry of Education; from Peace Corps' library in the capital city; from ICE; from sources in the United States, India, Honduras, and other countries; and from her personal files. She had also asked her education colleagues in the Ministry of Education and in the teacher training college to help her create a workshop design that could help the sixteen teachers invited to the writing workshop create appropriate activities for their country.

Unlike many others who try to develop environmental education materials, Janell had done her homework. From the start, she had involved her colleagues in the curriculum development process and had made it a collaborative effort. Then, instead of trying to use activities verbatim that were written in other countries, she had decided to sponsor a series of writing workshops so that she and her colleagues could adapt existing activities and develop new activities that were more appropriate for her country. She also spent time gathering many successful activities and resources to serve as models so that she didn't have to "reinvent the wheel" and could adapt what already existed.

Although there are many ways to ensure success when developing an environmental education program, certain steps are critical. In this chapter, we'll review some ways you can help guarantee that your environmental education programs will really work. We'll also look at how to overcome barriers, such as lack of teacher training, materials, money, and community support.

GETTING "BUY-IN" FROM THE BEGINNING

No matter what type of environmental education program you hope to develop, it is critical to get support from the beginning. When you first start planning a project, think about what you will need to make the program successful, how you can build capacity, who will be implementing the program, who can help you promote it to the community, and how to show those connected to the program (parents, school administrators, and so on) why it's in their interest to support it.

By getting people involved from the beginning, you can get important feedback and advice to ensure that the program is successful and culturally appropriate. This up-front buy-in can also help create a feeling of ownership in whatever program you are trying to implement. And this ownership can translate into professional support and encouragement, monetary support, or other types of general assistance and can help ensure that your environmental education programs continue long after you leave your assignment.

> *Patience and a mulberry leaf will make a silk gown.*
>
> —Chinese Proverb

To make your program successful, you need the support of your colleagues and school counterpart teachers, as well as school administrators. You also need support from parents and community members, from local education experts, and from the students you will be teaching. In some cases, depending on the scope of your program, you might also need input from local officials and area business leaders and nationally recognized educators.

What are some ways to get people involved in your programs? Find out who in your school, community, and country is already involved with environmental education and what types of programs and materials have been developed. Also talk with your colleagues to see if they have an interest in working with you as you assess the environmental problems in your community, size up the school situation, and begin to map out an environmental education program.

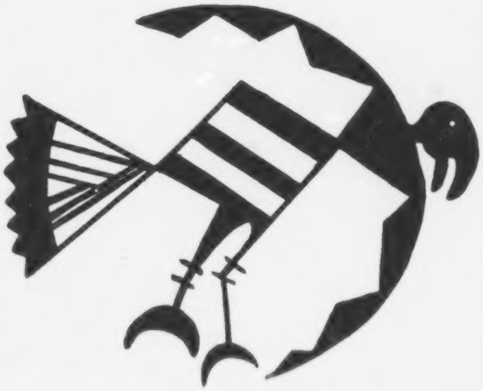
If you are developing a course or curriculum, work with a steering committee made up of colleagues, other teachers, administrators, teacher training departments, Ministry representatives, and anyone else who might be involved or share an interest in the decision-making process.

This committee can help guide the process, develop a philosophy and establish goals, offer comments, and ensure sustainability once you leave.

If the formation of a committee is not realistic, it's still important to get as much support as possible before you begin and to continually get feedback as your program develops.

FINDING AND DEVELOPING EDUCATIONAL MATERIALS

As you develop an environmental education program, you will need to find or develop teaching materials to make your program work. In many countries, you will find that environmental education materials do not exist or are unavailable to most teachers and schools. Here's a a quick overview of the types of materials that can help make an environmental education program successful and how you can help fill in the gaps when faced with a lack of materials.



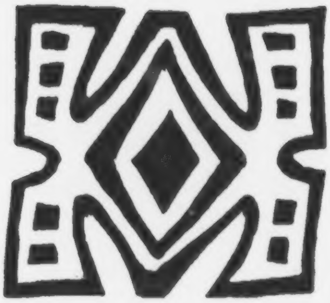
CURRICULUM GUIDE OR SCOPE AND SEQUENCE (*outlines environmental education content and indicates what should be taught in each grade level*):

As we mentioned in Chapter 6, a curriculum outline or scope and sequence describes what needs to be taught and when it should be taught. Usually a general curriculum guide or scope and sequence outline exists; however it might not include environmental content. It's also possible that your school or university does not have a prescribed curriculum or course outline. This means that you, along with your curriculum committee, might develop one or add an environmental component to an existing one. (See Chapter 6 for more about the nitty gritty of developing an environmental education scope and sequence.)

REFERENCE MATERIALS (*provide information about environmental subject matter, including specific information about the environmental problems your country faces*):

In many countries, resource materials about environmental issues, natural history, and related topics do not exist. This makes it difficult for teachers who do not have an environmental education or science background to teach about these topics. In some cases, information about environmental quality does not exist or is not available to non-specialists. Many times, people outside a country will have more information about the environmental issues within a country than the people who live there.

One way to increase the number of teachers who incorporate environmental education into their teaching is to provide user-friendly reference materials on the topics that are needed. By having access to high-quality materials, teachers are more likely to include environmental education activities and gain confidence in their ability to implement an environmental education program. You can either help create new resource materials or try to find existing materials. (See the Bibliography for more about how to obtain environmental education resource materials that might be appropriate.)



Textbooks (*the most commonly used teaching tool; providing teachers with a structured format, student readings, and teaching suggestions about a particular topic*):

There are pros and cons to using textbooks in your teaching. Good textbooks provide students with interesting and relevant information about the topics and contain activities, quizzes, and discussion questions. They can also provide teachers with a structured teaching sequence that is especially useful to a beginning teacher.

Unfortunately many textbooks are poorly written, out-of-date, and inappropriate for the country where they are being used. And many teachers rely on textbooks almost exclusively, which can limit discovery learning and promote passive learning. In many developing countries, textbooks are scarce. And textbooks that focus on environmental issues are very scarce—in both developing and more developed countries.

If textbooks are not available in your school, you can work with your colleagues to develop alternative teaching materials, including activity guides (see below). Or you can try to locate textbooks that can be used in conjunction with other teaching materials. You might find that some organizations are willing to donate textbooks or send you sample copies that you could share with your colleagues. (See page 433 for how to find financial support for your programs.)

Activity Guides (*provide teachers with teaching strategies, lesson plans, and/or activities on a variety of environmental topics and issues*):

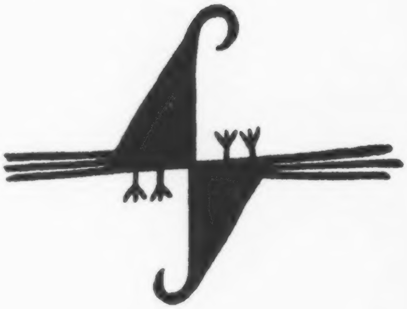
Sometimes, curriculum guides, national syllabuses, and textbooks include teaching activities, although the quality and extent of the activities vary. In other cases, the standard curriculum materials do not include teaching activities. In many instances, curriculum materials that include activities do not include environmental education teaching strategies or activities.

Supplementary activity guides often provide teachers in many countries with a variety of teaching strategies. *Project WILD, Project Learning Tree, NatureScope*, and *Living Lightly on the Planet* are all examples of supplementary environmental education activity guides used extensively in the United States, and the *Joy of Nature* is an example of a supplementary environmental education activity guide used in India. Many of these materials, however, have been written for students in a particular country and may not be appropriate for use in other countries. Given the lack of such resources in many schools, teachers feel that these activities are better than nothing and infuse them into existing curricula as they are. In other cases, motivated teachers adapt the activities to fit the country and culture.

Before thinking about developing new activity guides, work with your colleagues to see what, if any, materials exist in your country. Which supplementary guides, if any, have been endorsed by the Ministry of Education? What is the quality and availability of existing materials? You might find that there are good activities, but there has not been enough money to publish or distribute them to teachers. Or you might find that there are gaps that could be filled if a series of teacher writing workshops were held to develop new activity supplements.

Visual Aids (*posters, flip charts, pictures, slides, models, and other visual aids that help enhance lectures and teaching*):

In many schools, visual aids are not available—especially aids that could supplement an environmental education program. And in those schools that do have access to some visual aids, such aids are often of limited quality and availability. In some cases, inappropriate or inaccurate materials are used and considered better than nothing.



There are many visual aids that you can make from inexpensive or free materials. See Nonformal Education Manual (ICE #M0042) for information on how to make flannel boards, bulletin boards, chalkboards, posters, and so on. You might also try to get support to sponsor "make and take" workshops so that teachers can work together to create visual aids for a school or district.

Teaching Materials (*gameboards, scientific equipment, chemicals, chalk, paper, pens and pencils, and other basic teaching materials*):

In many developing countries around the world, teaching materials in general are very scarce—including materials that are taken for granted in U.S. schools. For example, microscopes, chemicals, collecting jars, flip chart paper, glue, electricity, scissors, and other basic supplies are often unavailable or are in short supply. (See the Bibliography for the addresses of biological supply companies in the U.S. Check with local universities for sources of local supplies.)

A FEW FINAL REMINDERS ABOUT MATERIALS

You can play an important role in helping to develop and collect environmental education teaching materials, but keep these thoughts in mind:

- Environmental education activity guides and curriculum guides that are produced in other countries are often not appropriate for universal use. You should take these as models and use them to develop appropriate and culturally sensitive materials that fit your country's needs.
- It's always best if in-country educators can develop their own materials without "outsiders" taking the lead role. However, you can assist with materials development, including the design of writing workshops and so on.
- Since economic, political, and environmental conditions continually change, it's important to realize that environmental education materials should be flexible. Think about institutionalizing an effective process of developing materials so that new materials can continually be produced as needed.

- Many teachers enjoy developing educational materials and will appreciate being involved in a process that lets them grow professionally. In this way, modular development can also serve to increase teachers' teaching ability. And as mentioned earlier, getting buy-in and support throughout the process of developing materials is critical. It's also critical to get feedback from the teachers who will be using the materials.
- All materials should fit the environmental education goals and objectives outlined by the curriculum committee and should be consistent with the philosophy of the country and the school.
- Although some countries can afford to develop slick and attractive materials, others can't. Materials should be of the highest quality possible, given in-country expertise, local facilities, and available resources.
- Think of yourself as a technical adviser or facilitator who can help find sources of financial and technical support, bring interested parties together, contribute knowledge and expertise as needed, and work as a catalyst to establish an effective materials development process.

PILOT TESTING NEW MATERIALS

If you work in a school or university that is producing new environmental education materials, it's important to pilot them with other teachers, especially if the materials are to be used in schools throughout the country. Pilot testing is important for several reasons. It can help you determine if the materials are appropriate for regional or national distribution and meet the needs of both rural and urban educators. It can also help discover problems in the newly developed materials, and those that are culturally inappropriate or do not fit with the day-to-day realities of classroom teaching. Pilot testing can also help build ownership in the new materials and ensure that they are used at a later date.

Pilot testing involves identifying a small number of teachers who represent the schools, grade levels, and courses where the materials are to be used and who agree to try out the new environmental education program in their classrooms. These teachers can help provide feedback on how effective they felt the materials were, how their students reacted, and how they would change the materials to make them more effective. You can gather teacher feedback either orally or by using written questionnaires that accompany the materials.

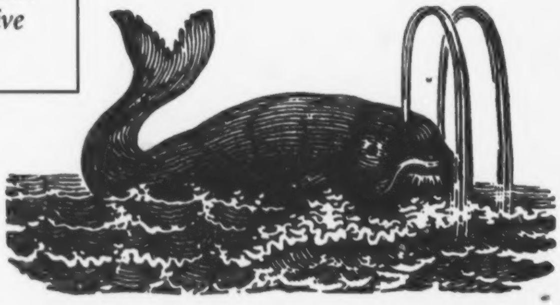
How do you select the teachers? It's best to get advice from others in the educational community, including your committee and the Ministry and to ask for volunteers. The teachers should reflect the range of teachers who will be using the program. Depending on the types of materials you are field testing, you might want to hold a training session for those teachers who will be piloting the materials. During the session, you can explain the goals and objectives of the program and demonstrate some of the activities. It's especially important to help teachers from rural areas with little science or teaching background feel confident that they can pilot the materials.

For some teachers, using classroom time to pilot a new program is not feasible. With large numbers of students and limited time to accomplish teaching requirements, teachers may have little motivation to get involved in something new. However, it's usually possible to find teachers who are already interested in environmental education and who like the challenge of working with new materials. You might also find that some teachers will volunteer to take part if you offer some incentives, such as:

- Honoraria to compensate them for the time spent in training sessions and pilot testing
- Certificates signed by the Ministry of Education or school officials recognizing their participation in the training session and in pilot testing
- Publicity in local newspapers about the new program and the teachers involved in the testing
- Teaching credit or bonuses
- Free environmental education materials

The curriculum committee should take the comments from pilot testing and use them to revise the curriculum. (Depending on the make-up of your committee, the burden for revising might fall to you and/or your counterpart.) For example, if most of the teachers say the materials don't work with large classrooms, you need to figure out if the problems can be resolved through teacher training or if the materials need to be substantially adapted.

Note: We recommend that you pilot test and revise any materials you develop. If your budget and schedule allow, you might also want to conduct a more formal field test before you publish a final version. A field test usually involves a larger testing group, gives teachers a longer time period to evaluate the materials, and includes a more formal evaluation. The materials are revised again, incorporating input from the field, and a final version is printed. Even though field testing takes additional time and resources, it can help you develop more effective materials.



Ten Steps to Developing Great Environmental Education Materials

1. Curriculum Committee (made up of teachers, administrators, and others) determines what is needed (workshops, questionnaires, etc.)
2. Curriculum Committee sponsors writing workshops, involving teachers, experts, and so on.
3. A writing team takes the materials developed in the writing workshops to produce a draft for pilot testing.
4. Teachers are selected to pilot the materials.
5. Materials are sent to pilot teachers and to content experts for review.
6. Materials are revised based on feedback.
7. Materials are published in field draft form.
8. Field drafts are sent to a second round of teachers and content experts with evaluation forms.
9. Feedback from the field test is incorporated into a final revision.
10. Implementation process begins.

Teacher Training

Research has shown that when teachers are introduced to new materials in a workshop and have an opportunity to ask questions, practice using the materials with their colleagues, and develop new lesson plans based on the materials, they will be more likely to use the materials in the future. Workshops designed to introduce new materials can also help motivate teachers—especially when good teaching materials are scarce. That's why it's so critical to think about how the materials will be implemented in the beginning stages of a project and to work out funding for in-service and pre-service workshops. If possible, ask the teachers who were involved in the pilot testing and the teachers who helped create the materials in the first place to help conduct the training. Also, think about incentives for both the trainers and the teacher participants.

The length of a training workshop depends on the complexity of the materials and the abilities of the teachers who will be using them. If you are introducing a new curriculum, you might need to spend several days to a week to train teachers how to use the materials. For supplementary materials or smaller projects, you might be able to introduce the materials in shorter amounts of time.

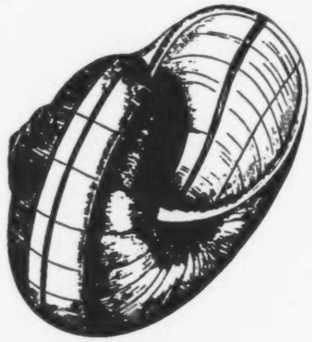
You might also want to consider workshops that train teachers to be trainers. By training one teacher from each region to train teachers in other schools, you can help stimulate teachers' professional growth and interest while ensuring the effective implementation of the program throughout the country. You might also want to introduce new materials at teacher training colleges and universities.

There are many ways to design a training program. (See ICE manual for tips about training teachers.) But it's important to make the workshop an active, hands-on experience that complements the materials you are trying to implement. In addition to explaining goals and objectives and demonstrating activities and techniques, it's important to include sessions that help teachers who are used to lecturing 100% of the time feel more comfortable with small group activities, cooperative learning, and discovery learning. Also think about a follow-up to the workshop and establishing a mechanism for teachers to evaluate the materials, comment on them, and share problems, concerns, and successes.

FUNDING YOUR EE ACTIVITIES

Throughout the world, but especially in developing countries, education programs are often underfunded. Many teachers are underpaid, money is not available for training or materials, education departments are understaffed, and physical conditions are difficult.

In many countries, Peace Corps Volunteers and counterparts have discovered creative ways to get funding for new programs. Some of these funds come from international sources. Others come from local businesses, conservation groups, and community outreach organizations. Here are few suggestions for where to dig up money for your programs:



INTERNATIONAL SOURCES: Many environmental education programs have been funded by international organizations that give money to developing countries to improve education, health, the environment, and training. These include aid missions in developing countries, such as the U.S. Agency for International Development (AID); multi-lateral organizations such as the World Bank and the Food and Agricultural Organization of the United Nations (FAO); private development organizations such as Save the Children and CARE; and environmental non-governmental organizations (NGOs), such as World Wildlife Fund and Wildlife Conservation International. (See the Bibliography for a list of international funding organizations.)

PEACE CORPS FUNDING: The Peace Corps Office in Washington, D.C. may be able to help you develop and implement an environmental education program in a variety of ways. Start by working through your Associate Peace Corps Director (APCD) or Program Manager to determine if training or money is needed. If your APCD feels that the country needs and wants assistance, he or she can apply for funding and training through the Office of Training and Program Support (OTAPS). Peace Corps Washington also has a special program called "Peace Corps Partnerships." This program is designed to help private industry and schools in the United States donate money to help fund specific community projects in Peace Corps countries. You can also apply for money through Peace Corps' US AID's "Small Projects Assistance" or SPA program. SPA funds can be used to suppport commmunity-based programs that build local capacity. (For more information contact your APCD or Country Director or write to SPA, U.S. Peace Corps, 1990 K Street, NW, Washington, D.C. 20526.)

LOCAL FUNDING: The best places to start looking for funding within your country are local conservation-education NGOs. There are many established conservation groups, as well as many new groups that are springing up in response to the increasing environmental problems worldwide. Like U.S. environmental groups, they are involved in a variety of activities, ranging from environmental advocacy to education. Many consider environmental education to be a top priority. (As a secondary project, you might want to get involved in helping a fledgling NGO organize, raise funds, and develop educational outreach programs to improve environmental education efforts in the country.)

You might also be able to generate funding right in your own community. For example, consider organizing local activities, such as dances, fairs, raffles, and bake sales to raise funds for training and materials development. You can also sell products such as T-shirts or calendars at a local event. (Later, you may be able to extend your sales to include a wider region or even the whole country.) . For example, a Volunteer working in a park in Senegal developed and marketed picture postcards to the public to raise additional money for educational programs. Corporations active in developing countries are often willing to help out with local projects or events, especially if they receive some publicity and good will in the process. Pepsi Cola paid for litter baskets (with the Pepsi logo) that were distributed throughout Asuncion, Paraguay. By working with in-country educators and NGOs to write grants and proposals, you can help develop fundraising capacities within the country.

MAINTAINING PROGRAM SUPPORT

Once an environmental education program is implemented, it's important to maintain the support and interest of teachers, parents, school administrators, Ministry officials, and the public. There are many ways to ensure continued program support, including the following:

PUBLICIZING THE PROGRAM: Publicity can help ensure your program's success. You can help increase the amount of media attention the program gets by staging events to let the community know what you and your colleagues and students are doing. For example, you can stage a tree-planting demonstration, an environmental fair, a clean-up, or some other activity to interest the press and the community. Or you can see if writers and broadcasters would like to interview students and teachers in your schools or sponsor a program dealing with environmental education.

MAINTAINING ON-GOING ADVISORY COMMITTEES: Even after an environmental education program is established, it's important to maintain an advisory committee to oversee content, implementation, and revision of the program. The Committee can also help promote the program's successes and seek additional program support.

Replicating Models: If an environmental education program in one school or district is successful, replicating the model in other schools or districts can help ensure the institutionalization of environmental education in the country.

Building Networks and Keeping People Informed: School administrators, funding sources, local environmental NGOs, and other interested parties should be kept informed of the program's progress. By sharing what students are doing, such as essays, posters, displays, and news clippings, you can help build support for the program. In some countries, environmental education newsletters outlining teacher and student activities help keep interested people informed.

Evaluating the Program: On-going evaluation is a critical part of an environmental education program. We'll discuss this more in Chapter 9 on page 439.

SUMMARY

An environmental education program, no matter how well-designed, won't help improve environmental quality in a country if effective materials are not available, if teachers are not trained or motivated to use the materials, if funding does not exist to reproduce and distribute materials, and if the community, Ministry, and others have not participated in the process. To ensure continued program support, it's important to map out a strategy before you begin and get the necessary support up front.

QUESTIONS

Materials

1. *What materials does the education program need?*
    - *curriculum outline*
    - *activity guides*
    - *teacher reference materials*
    - *student textbooks*
    - *visual aids*
    - *other teaching materials*
2. *Who was involved in the decision to produce environmental education materials? Have teachers been consulted?*
3. *Who will prepare the materials? How will they be trained and paid?*
4. *When will the materials be completed?*
5. *Where will funding come from?*

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> *Vision is the art of seeing things invisible.*
>
> —Jonathan Swift

PILOTING NEW MATERIALS

1. *How will the teachers who will be piloting these materials be trained? Who will conduct the training workshops and how will the teachers attending be compensated?*
2. *What materials will need to be ready for the pilot testing?*
3. *How will the pilot teachers evaluate the curriculum materials? Through questionnaires, meetings, or telephone calls?*
4. *When will the testing be completed? When do you expect the revised curriculum to be ready for general distribution?*

TEACHER TRAINING

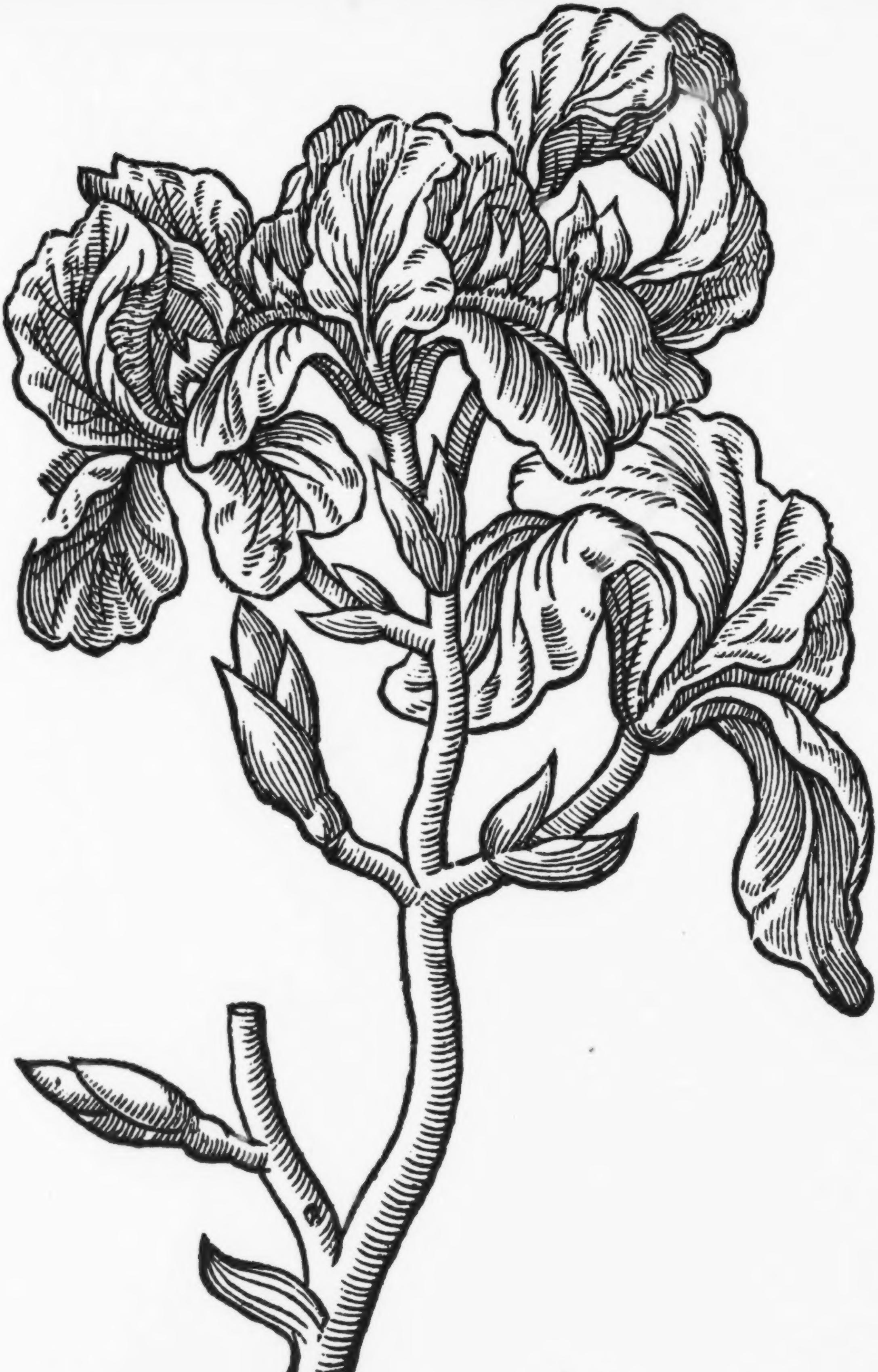
1. *How will teachers be trained to use the curriculum or activities? (Through in-service workshops, classes at the teachers' college, etc.)*
2. *Who will conduct the training? Will the training be a one-time event or the first in a series of training workshops? Will there be any follow-up training?*
3. *In addition to the curriculum materials, what materials are needed during the teacher training workshops, if any?*

FUNDRAISING

1. *What international sources of funding are available in the county?*
2. *What possible sources of funding exist within the county?*
3. *Does the environmental education program complement the goals and agendas of local conservation education organizations in the country?*

MAINTAINING PROGRAM SUPPORT

1. *Who can lend substantive technical, educational, and other assistance to the program?*
2. *Whose support is needed for the environmental education program to continue?*
3. *What can motivate these people to lend support to the program?*
4. *How can you increase host country ownership in the program to ensure success?*



Workshops in the South Pacific

From conducting teacher workshops to sponsoring beach clean-ups, Peace Corps Volunteers are actively working to help Fiji, Tonga, and Western Samoa address environmental issues. Starting in 1989, when a series of environmental education workshops were conducted for math and science teachers in each country, Peace Corps Volunteers have been incorporating environmental content into their lesson plans. Focusing on issues such as overfishing, destruction of the coral reef, and pesticide safety, education Volunteers are working with their colleagues to develop country-specific activities that help students understand local issues and evaluate alternative solutions. They are also trying to encourage field trips so that students get a chance to see and appreciate life on their island. On Tonga and Fiji, students have visited the city dump, explored a coral reef, learned more about endangered bats, and conducted an environmental survey.

9

MEASURING YOUR SUCCESS

If you hit every time, the target is too near or too big.

—Tom Hirshfield
Physicist

Therese had just finished her first year of teaching. She loved her assignment as a teacher in a busy community just outside the capital city. Although she had to deal with large classes and a chronic lack of materials, she really felt that she was making a difference. She was especially excited about the environmental education piece she had added to the ag-extension classes she was teaching in the secondary school. Many of the students had not only opened up and started asking questions, but they had also taken part in tree planting activities, a stream clean-up, and a community pesticide program. Therese had even gotten some positive comments from parents.

But one thing was troubling Therese. Despite her successes inside and outside the classroom, many of her students did poorly on the national exams. Although she was convinced that the environmental content she was teaching was relevant to her students' lives, it wasn't helping her students pass the tests. Should she change her strategy for next year? Was it the standardized test that was at fault? Her teaching methods? The school's curriculum? How could the next PCV at her site improve on her efforts?

Like Therese, all teachers and administrators are faced with questions about what to teach, how to teach it, and how to measure success. In Therese's case, she was comparing high marks in nonformal evaluation (environmental improvement in the community, high grades on non-standardized tests, positive student attitudes) with low standardized test scores. But she was confused about how to use the information to plan her teaching strategy for the following year. Was it better for the students to learn practical knowledge about their local environment or facts and general knowledge that could help raise their test scores? Or was it possible to do both?

In this chapter, we'll look at four major topics related to evaluation:

1. **WHY EVALUATE?**
2. **WHAT TO EVALUATE**
3. **HOW TO EVALUATE**
4. **HOW TO USE EVALUATION TO GAIN SUPPORT FOR YOUR PROGRAM**

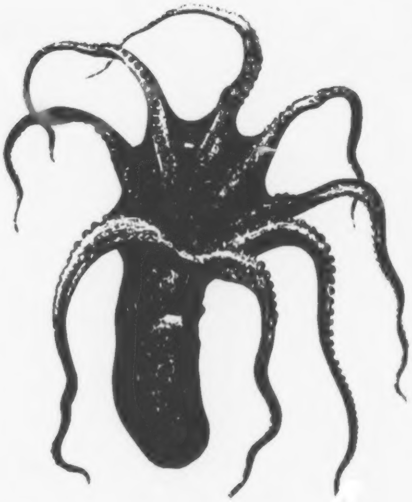
Specifically, we'll look at strategies for how to evaluate your program, from deciding what's most important to evaluate to how to use the results of the evaluation to improve your program, measure student progress, and gain support. We'll also discuss formal and nonformal evaluation techniques, grading, and how to measure attitude changes. Of course, the ultimate test of any environmental education program is whether it has improved environmental quality. But many other factors need to be considered when evaluating an environmental education program, including:

- the needs of the students
- the demands of the community and administration
- available resources
- short-term versus long-term goals
- how well your environmental education objectives help fit in with and enhance other curricular objectives.

It's also important to keep the "evaluation" tips and tricks (in the margin) in mind as you develop your program.

EVALUATION TIPS AND TRICKS

- *Build evaluation into your program from the beginning. (As you develop objectives, you need to be thinking about how you will evaluate success.)*
- *Help students take an active role in the evaluation process by encouraging them to offer suggestions and comments about how to improve instruction throughout the year.*
- *Make sure the evaluation process is fair and realistic for all students.*
- *Make evaluation an on-going process.*
- *Share the results of your assessment with students, administrators, and parents.*



WHY EVALUATE?

There are many reasons to spend time and resources evaluating your environmental education program. Evaluation can help you determine how effective your teaching is and how well your students have learned the material, as well as provide you with the information you need to improve your teaching. Evaluation can also help motivate students by giving them rewards (high test scores, gold stars, and so on) and feedback (how to improve weaknesses, how to make the most of strengths). Evaluation is also important because it lets administrators, parents, and community leaders know what's happening, which can mean support for your program down the road.

WHAT TO EVALUATE

Deciding what to evaluate is the most important part of the evaluation process. Although your main goal is to assess how well you achieved your objectives, you might also decide to evaluate other aspects of your program, including the effectiveness of certain teaching techniques, how well your program has enhanced the school curriculum, and so on. However, in most schools around the world, resources are scarce—especially for evaluation. So it's important to focus on what you really need to know and build that evaluation into your program from the start. We recommend that you evaluate both student learning and the effectiveness of your program, using a variety of formal and nonformal assessments.

Unfortunately, many teachers think about evaluation as part of an "end of the year" or "end of the course" wrap up. They ask themselves questions after the fact, such as:

- Did my students learn skills that will help them solve environmental problems?
- Are they motivated to take action to solve local environmental problems?
- Did they gain knowledge about environmental issues and solutions?
- How efficient was my teaching?
- Did the activities make the best use of my limited resources and time?
- Was there a better way to achieve the results I hoped for?
- How did my students do compared with students in other parts of the country?
- Did my objectives match those of the community and administration?

- Did my students enjoy themselves and get excited about learning and environmental education?

A [person's] errors are his or her portals of discovery.

—James Joyce

These questions are all good questions, but it's important to think about them from the start, as you plan an environmental education program.

One way to help decide what to evaluate is to list the questions you think you'd like to answer through an evaluation process. For example, Dean Bennett, in "Evaluating Environmental Education in Schools" suggests that you consider these questions before you begin planning an evaluation:

- How much growth in learning occurred because of the program?
- What aspects of the instructional program contributed to the results of the program?
- What aspects of the learning environment contributed to the results of the program?
- How did the program affect other people and the environment?
- Is the program's rationale valid, and are the goals and objectives appropriate?
- How do the results compare with those of similar or alternative programs?

It's also important not to rely on one type of evaluation to measure success. Both formal evaluation (classroom tests and standardized tests) and informal evaluation (interviews, observation, homework, group projects, class discussions, and so on) are important. And in many cases, informal assessments are much more telling than test scores.

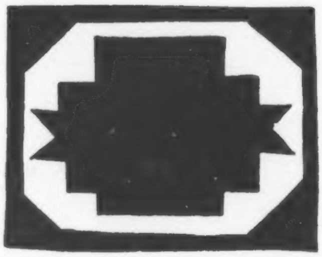
STUDENT LEARNING

Assessing student learning is directly linked to the objectives you develop for your program. As we mentioned in Chapter 2, your objectives should be tailored to meet the needs of your students and the environmental problems facing your community, and they should indicate how you would like your students to behave or perform as a result of your teaching program. They should also indicate the skills, attitudes, and knowledge you feel are most important for your students to acquire as a result of your teaching. An effective evaluation program can help you determine whether you met your objectives and how they could have been met more effectively or efficiently.

PROGRAM EFFECTIVENESS

When you evaluate an environmental education program, it's important to critique the program itself, as well as how much your students learn. From teaching methods to classroom environments, there are many pieces of your teaching program that you might want to evaluate. Here are some examples of questions that can help you evaluate your program's effectiveness:

- Were the teaching techniques you chose effective?
- Was there too much lecture?
- Too many outdoor activities?
- Too much paper and pencil work?
- Was the program flexible enough to adapt to students' changing interests?
- Did the classroom environment inhibit or promote learning?
- Did the program affect community members?
- If so, how did they feel about the program?



EVALUATE WISELY!

Although evaluation is a critical piece of your environmental education program, it's important to evaluate only what you need to know. Extraneous evaluation wastes time and money, and in some cases may prevent you from spending time improving your program in the areas that count most.

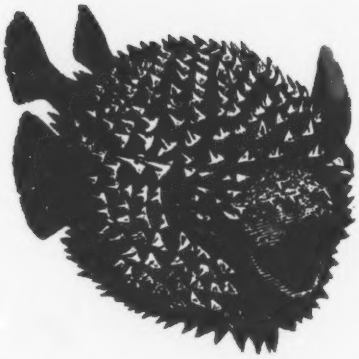
WHAT'S IN A WORD

There are a variety of different terms used in evaluation. In this book, we are using the terms *formative* to mean on-going monitoring and *summative* to mean the final evaluation. However, some people use the terms *program monitoring* or *intermittent impact analysis* instead of formative evaluation and impact analysis instead of summative evaluation.

HOW TO EVALUATE

In this section, we'll look how to evaluate your program by choosing the appropriate type of assessment. Specifically, we'll look at:

- pre-assessments and gathering baseline data
- formative vs. summative evaluation
- what makes a test reliable, valid, and useable
- pros and cons of standardized vs. teacher-made tests
- pros and cons of different types of test questions



- types of informal assessment tools, including
    - homework
    - journals and notebooks
    - research and reports
    - discussions and debates
    - peer evaluation and self evaluation
    - interviews
    - questionnaires
    - public displays
- the value of portfolios
- measuring attitude change

TYPES OF EVALUATION: PRE-ASSESSMENT, SUMMATIVE, AND FORMATIVE

For the most part, you will probably be dealing with two types of evaluation: *formative evaluation and summative evaluation.* **Formative evaluation** measures progress periodically throughout the year using formal tests as well as observations, quizzes, class discussions, notebooks and journals, reports, homework, and other informal evaluative techniques. It allows you to give your students constant feedback to help focus and improve learning. It also allows you to gain insights into how to adjust your teaching program to make it more effective and efficient. **Summative evaluation** measures the end results of your instruction and helps you determine if your students have mastered your course objectives. Summative evaluation often takes the form of a standardized or teacher-prepared "end-of-the-year" test, but it can also include an "end-of-the-year" questionnaire or survey.

In some cases, you will also have an opportunity to assess how much your students know before you begin teaching. This type of evaluation, called a pre-assessment, can take the form of a formal test or an informal questionnaire, interview, or survey and can provide important baseline data.

Formative and summative evaluation, as well as pre-assessments, are important parts of an evaluation program and rely on formal and informal evaluation techniques. When designing an evaluation program and choosing an assessment tool, keep your specific situation in mind from the start. For example, large class sizes, lack of materials, lack of support for informal assessment, and many other conditions can make certain types of evaluation difficult. It's also important that you chose the right tool. In many cases, teachers make the mistake of using an assessment tool that does not measure what they've been trying to teach. For example, if you've been teaching problem-solving techniques and lab procedures, a multiple-choice test is not the best measure of your effectiveness. A hands-on, practical exam would be more appropriate because you could actually evaluate whether your students can conduct a successful lab activity or solve a real problem—two skills that can't be measured on a multiple-choice test that mainly tests factual knowledge.

We suggest that you do your best to try to incorporate formal and informal evaluation into your program, realizing the limitations you face. Here's more about the pros and cons of formal testing and informal methods of evaluation.

TESTS, TESTS, TESTS: FORMAL EVALUATION

In many school systems around the world, formal testing is the preferred means of evaluation. Tests are quantitative measures of student performance and some can be used to compare students to other students and measure improvement over time. Tests are more objective than informal testing because they rely on quantifiable data. There are generally two types of tests you will be working with: standardized tests that are prepared by others and classroom tests that you prepare.

When creating a test or selecting a test, you need to think about these three characteristics: reliability, validity, and usability.

RELIABILITY: A reliable test is one that will give the same results over and over again. It's consistent, dependable, and stable. It's important that a test is reliable so that you can count on the results. For example, if you give the same test to the same group of students three times in a row in a short period of time, the results should not fluctuate widely. If you use a different form of the test, the results should also remain consistent. If they don't, the test is not reliable. For example, if you have two test items to measure one objective, do the students who get one right also get the other right and the students who get one wrong get the other one wrong too? You want a test to be reliable so that you can count on it to test for the same things no matter who you give it to and when you give it. To improve reliability, you can increase the number of test items, give the test to a mixed student group, include test items that are of moderate difficulty rather than of mainly easy or hard questions, double check to make sure all test items are clear and understandable, and use test items that can be scored objectively rather than subjectively.

VALIDITY: When a test is valid, it measures what it's designed to measure. For example, if you are trying to test if your students have achieved the following objective "Given a plow, students will be able to plow on the contour to help prevent soil erosion" but test by using a test item that asks why it's important to plow on the contour, your test will not provide a valid measure of this objective. To test for that objective, you need to actually see the students plow. Or if your objective is to have students list three causes of reef destruction, but the test question has students list three causes of ocean pollution, the test item doesn't match the objective. If the test question were to ask students to list three causes of reef destruction, the question would be valid.

One way to make sure your test is valid is to double check each test item and make sure each is measuring your pre-determined objectives. You can also ask your colleagues to rate your questions against your objectives to make sure they match.

Usability: You should also select tests based on how easy the test is to use. In addition to reliability and validity, you need to think about how much time you have to create a test, grade it, and administer it. You need to think about how you will interpret and use the scores from the tests. And you need to check to make sure the test questions and directions are written clearly, the test itself is short enough not to overwhelm the students, the questions don't include stereotypes or personal biases, and that they are interesting and make the students think.

STANDARDIZED TEST VS. TEACHER-MADE TESTS

There are generally two types of tests used to evaluate environmental education programs: *standardized tests* (prepared by publishing companies, formal testing agencies, and universities), and *classroom tests* (prepared by the teacher).

Standardized tests are formal tests that allow you to compare your students with other students in the region or country. These tests are usually valid and reliable because they have been tested on large sample populations and have been revised to eliminate unreliable or invalid questions. They are useful if you want to compare your students with other students or if you want to rank students against the "norm." (Ratings of validity and reliability are published for standardized tests and you can check on the documentation.) The norms for standardized tests depend on where the tests were developed. (U.S. norms may not be appropriate for non-U.S. students.)

One serious drawback to standardized tests is that they are not effective with students that have abilities, needs, or problems that differ from those of the "normal" student population. In addition, the content of standardized tests does not always match what is taught in a certain school or classroom. As Therese found out, many students in less developed countries do poorly on standardized tests—especially on tests that are developed in other countries. One reason for this is that these tests are usually given in English, which is a second language for many students. Another reason is that the content and culture of the test usually does not match the classroom content and culture in a particular school.

Standardized tests are often not appropriate measures of environmental education learning. Not only do the questions often not deal with environmental issues or ecological content, but the types of questions mainly test for knowledge and facts—not skills and attitudes, two important components of an environmental education program. Although standardized tests are changing to include more variety and to encourage higher-level thinking, they are still very limiting and should not be used as the sole measure of a student's performance.

Standardized tests definitely have their drawbacks. Yet, in many school systems, scores on standardized tests determine a student's academic future. If a student passes, he or she can move ahead. If a student fails, he or she will not have the same opportunities. The number of students that pass and fail is also seen as a reflection of the quality of teaching and the success of the school system itself.

Note: Some established textbook and curriculum programs may include regular progress tests based on the goals and objectives of the program. Unfortunately, these tests are often multiple choice or true/false and usually don't measure attitudes and skills.

Unlike standardized tests, **teacher-developed tests** have not been tested on sample populations of students and do not allow you to compare your students to a standard. Instead, these tests (also called criterion-reference tests), help test a student's understanding of a particular (and often limited) body of knowledge. For example, if you are teaching a unit on ecology and want to determine whether your students have learned about predator-prey relationships in Belize, you would include test questions about predator-prey relationships in Belize that related to your specific objectives. You could also include questions dealing with knowledge and attitudes about predators and make the questions as easy or difficult as you wanted, based on the objectives you outlined earlier.

Many teachers prefer criterion-reference tests because the evaluation is based solely on the students' performance and the test relates directly to what was taught during the course. If everyone in the class can match the performance outlined in the objectives, then everyone gets top marks. Criterion-reference tests make a lot of sense for environmental education because if you design the right type of test, you can determine if your students have learned what you hoped they would learn. Criterion-reference tests can measure skills, knowledge, and attitudes—the three major components of your environmental education program, and they can be tailored to meet the environmental needs of your community.

The drawbacks to teacher-made tests are that they are often unreliable and less valid than standardized tests, and their effectiveness relies on the skill of the individual teachers who create the tests and grade them. If you don't have a lot of experience designing effective tests, you might want to meet with several of your colleagues and work together to come up with good questions.

When creating a test, it's important to match the test questions to your objectives. It is also helpful to ask yourself the following questions:

- Does this test match the level of difficulty I covered in the class?
- Does the test provide a representative sampling of the material I presented in class?
- Does each test question measure one or more of my objectives?

Of course, it's also important to match the type of test you give to the material you are trying to teach. For example, you might not want to give students an essay test to see if they learned key ecological vocabulary words, since a short answer test would be more efficient. But you might prefer an essay test if you are trying to evaluate how your students organize their thoughts and can analyze and evaluate an environmental problem in their community. Here are some tips and tricks about when to use short answer tests (multiple choice, fill-in-the-blank, true/false, and matching) and when to use essays, along with some examples of each:

USE SHORT-ANSWER TESTS WHEN YOU:

- have a large number of students
- want a reliable test that is quick and easy to grade
- feel more comfortable about your ability to create short answer test questions that reflect your objectives than about grading an essay test objectively and determining whether your objectives have been met
- have more time to develop the test than grade it
- want to measure broad content
- are working with lower level primary students
- want to test for simple facts and vocabulary words

USE ESSAY TESTS WHEN YOU:

- want to test for critical and creative thinking skills such as problem solving, analyzing, and evaluating
- want to evaluate written communication skills
- have more time to grade a test rather than develop it
- want to make sure students can't "guess"
- want to know how much in-depth understanding students have
- want to evaluate how well students can organize their thoughts
- don't have access to copying facilities and need to write questions on the chalkboard or on a flip chart

SHORT ANSWER TIPS AND TRICKS:

- Make sure test questions measure the objectives you feel are most important.
- Don't include trick questions or "trivial pursuit" questions.
- Check for and eliminate stereotypes and bias.
- Try to make each question independent. Students shouldn't be able to answer one question by reading another.
- Make sure questions are easy to understand and well-written.
- Match the number of questions to the time/emphasis you put on objectives in class. If you spent 10% of the class focusing on objectives related to acid rain and detecting bias, then about 10% of the test should reflect that.
- Match the length of the test and the time given to take the test to the abilities of your students. (Some students need more time and fewer questions.)
- Don't include choices that are obviously wrong. (However, you might consider including occasional choices that are ridiculous or funny if you want to lighten the mood of the class a bit.)

Each type of short answer test has pros and cons. For example, multiple choice questions can test higher level thinking skills and in-depth knowledge, but they are more difficult to construct. And true-false tests are the easiest to construct and grade, but encourage guessing and often test for trivia. We recommend that you use a mix of questions and testing strategies to evaluate your students.

ESSAY TIPS AND TRICKS:

- Make sure the directions are clear so that students can focus their writing.
- Match the questions to the objectives you feel are most important.
- Set up an objective scoring system and explain it to your students. Also let them know how much each question is worth.
- Give students enough time.
- Give students a choice of questions. (Choose any 3 out of 6.)
- Make the most of the questions. Encourage students to think, evaluate, organize, and analyze.
- Don't give one-question essay tests.
- Balance essay questions that require long answers with those that require shorter answers. (This will help increase the amount of material you can cover.)
- Grade each essay question on each paper before moving onto the next. (Grade all the answers to question 1, then all the answers to question 2, and so on.) This will help you grade the answers more objectively.

Regardless of the type of test you decide to construct, it's important to use tests to help you find out the process your students use to think. Although student tests scores tell you how well your students performed, they don't tell you how students came up with their answers. One way to get around this is to give the students a test, record the scores, and then give the tests back to the students to discuss how they came up with the answers. You can use small groups or individual interviews to ask students how they came up with their choices. By asking students to think about their answers, you can discover misconceptions they might have and what type of thinking process they used to come up with their answers. Try asking questions such as "Why do you think this answer is correct?" What did you think the question was asking? Can you think of another way to answer the question?"

Another thing you might want to keep in mind as you develop a test is to keep a balance between lower-level thinking questions and higher level thinking questions. One way to do this is to use Bloom's taxonomy (see Chapter 4) as a guide. For example, Dr. Louis Iozzi, Dean of Science Education at Rutgers University in New Jersey suggests that you develop a chart that lists the topics in your lesson plans and the six levels of learning you have addressed through teaching and learning activities and check off each block to remind you what you have covered. When you develop an achievement test to cover the material, you should try to include one or more questions from each box that has a check. Here's an example from a secondary science unit:

Bloom's Levels	Non-Living	Abiotic Influences	Biotic Influences	Plants	Animals
Knowledge	✓	✓	✓	✓	✓
Comprehension	✓	✓	✓		
Application	✓	✓		✓	
Analysis	✓				
Synthesis	?	?			
Evaluation	?	✓			

Key:

✓ = this level was clearly addressed through teaching/learning activities

? = this level was either addressed by some, though not all students in the course, or could be addressed, depending on how the unit was taught

Ideally, all "cells" of this matrix that show a checkmark would be represented by one or more items on a unit achievement test. The exact number and type of items included is left to the discretion of the teacher, although it should attempt to reflect both stated objectives and teaching/learning activities.

Below we have included several sample test questions showing a variety of short answer and essay questions. These examples were reprinted with permission from *Assessment of Learning Outcomes in Environmental Education* by Louis Iozzi, Dany Laveault, and Thomas Marcinkowski (published by UNESCO, 1990).

1. TRUE OR FALSE

Acid precipitation is produced largely as a result of the burning of high sulfur coal and gasoline in automobiles.

2. COMPLETION QUESTIONS

Acid precipitation is produced when _____ mixes with _______ in the atmosphere.

3. MULTIPLE CHOICE QUESTIONS

Which of the following is not necessary for acid precipitation to occur?

a. water vapor
b. SOx
c. NOx
d. strong winds

Which of the following is not a cause of tropical deforestation?

a. slash and burn agriculture
b. logging
c. ranching
d. changing climate patterns
e. greed

Which of the following energy resources are renewable?

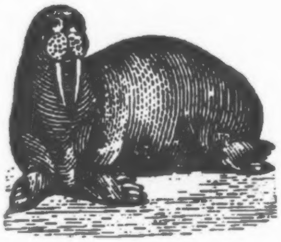
1. wood
2. tidal
3. nuclear
4. geothermal
5. coal

Which of the above energy resources are considered to be renewable?

a. 1 only
b. 1 and 2 only
c. 1, 2, and 4 only
d. 1, 2, 4, and 5 only
e. They all are.

Which of the energy resources listed above are directly traceable back to the sun's radiation?

a. 1 only
b. 1 and 5 only
c. 1, 2, and 5 only
d. 1, 2, 4, and 5 only
e. They all are.



4. Matching Questions

Match the words in Column A to their definition in Column B:

Column A	Column B
1.	a.
2.	b.
3.	c.
4.	d.
5.	e.

In the column to the left you will find definitions, and in the column to the right you will find terms. Your task is to correctly match the term to its definition by placing the term's letter in the blank space next to the definition. Use each letter only once.

Definitions	Terms
1. ______	a.
2. ______	b.
3. ______	c.
4. ______	d.
5. ______	e.

5. Short Essay Questions

Briefly describe the causes of desertification in Senegal and how the process can be slowed and controlled.

In the space provided below, define the term "desertification" and give a local example showing what causes it and what the consequences are when an area becomes desertified.

6. Open-Ended Assessments

In the spaces below, list as many different things you could do (or actions you could take) to help improve the environment.

Observe, Listen, Record, and Interview: Informal Evaluation

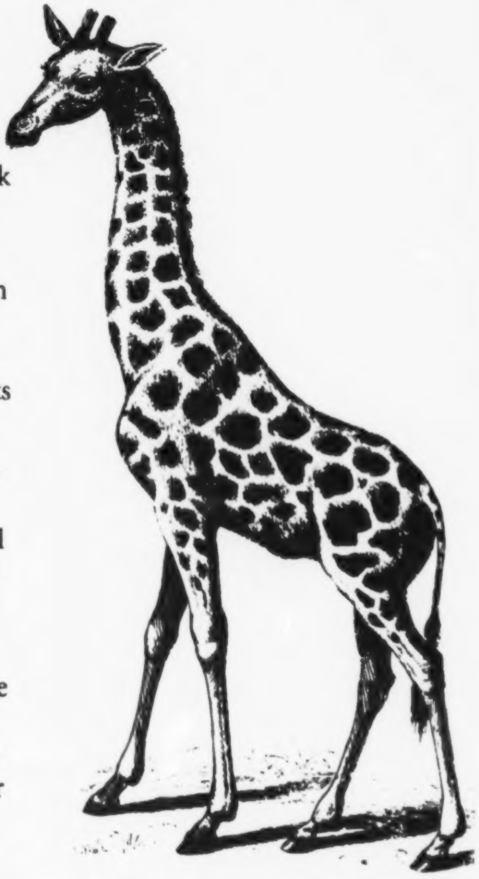
Most teachers instinctively evaluate their students and programs informally throughout the year. Informal evaluation allows you to spot problems long before formal testing can, and it can provide continuous and helpful feedback to you, your students, and your colleagues and administrators. There are many ways to evaluate your students and your environmental education programs informally. Here's a look at some of the most effective:

Keep An Eye Out: Observation, both inside and outside of the classroom, is an important evaluation tool. For example, Therese could see that her students were taking part in activities to improve the environment. She could see which students were planting trees, which ones organized the stream clean-up, and which ones took part in the pesticide safety day. She could also observe student behavior and performance in the classroom, and she knew which students were taking part in discussions and which students were actively involved in their learning.

Observation is most effective when you have an objective and systematic way of monitoring what you see. For example, you might want to keep a daily log or a checklist to document what you see and make notes to yourself (see below). It's also important to make sure you observe all students and keep learning styles in mind as you decide what is important to evaluate.

	PARTICIPATES IN DISCUSSIONS	**GIVES CREATIVE RESPONSES**	**WORKS WELL WITH OTHERS**
YAMAI			
DEREK			
LASZLO			

When holding debates and classroom discussion about environmental issues, you can take notes about which students participate or give students grades for classroom participation. (It's also important to help draw shy students into class discussions, if possible.) You can also observe student reactions to different teaching styles and activities, and learn valuable information from the questions students ask and the comments they make.



HONING IN ON HOMEWORK: Another way to informally evaluate your students and program is to consistently assign homework and then look it over carefully. Homework activities can evaluate activities that tests often can't. And by constantly checking homework and giving students feedback, you can get a good idea about how well your students are learning the information and how effective your teaching is.

Homework assignments can also "test" for skills and attitudes that are hard to evaluate from test scores. For example, a three-week homework assignment to plan and organize an environmental project can tell you a lot about a student's planning and organizing skills, which would be harder to test for. You can also give essay and report assignments to assess students' writing and thinking skills.

JOURNALS AND NOTEBOOKS: Keeping journals and notebooks is one way to find out what your students are thinking and to help them develop their writing skills. Writing in journals or notebooks can help them express themselves freely and encourage them to write about their feelings and beliefs. You can have students keep personal journals and give them the option of sharing their writing with you and asking for your feedback or not. You can also tell them in advance that certain parts of the journal will be graded and to only include writing that they want you to read. (See Chapter 7 for more about keeping a journal.)

Research and Reports: Learning how to find information about environmental issues and problems is an important component of an environmental education program. From using the library (if your community has one) to talking with parents and leaders in the community, your students can learn valuable research skills that they can use throughout their lives. Research assignments can also help them learn how to analyze information, document facts, distinguish facts from opinion, and organize their thoughts.

Discussions and Debates: As mentioned earlier, involving students in small group discussions, large group discussions, and debates about subjects they care about can help them learn to express their thoughts verbally, listen to other points of view, and clarify their own thoughts about how they feel. You can use these opportunities to evaluate how your students think and feel about a variety of issues related to the environment.

Because so many environmental problems involve group solutions, it's important to help your students learn how to contribute to group outcomes, work together, and cooperate more than they compete. Peter Martorella, in his book *Elementary Social Studies* (Little, Brown, 1985), recommends that teachers use discussions to evaluate their students on a variety of social characteristics such as:

- accepts ideas of others
- initiates ideas
- gives opinions
- is task oriented
- helps others
- seeks information
- encourages others to contribute
- works well with all members
- raises provocative questions
- listens to others
- disagrees in a constructive fashion
- makes an overall positive contribution to the group

Talk to Students, Teachers, and Parents: You can find out a lot about your students by talking informally with them throughout the year. When provided with one-on-one opportunities to talk, many students will open up, giving you a chance to gain insight into what they're thinking and feeling. Personal interviews also give you an opportunity to ask questions about your teaching style and approach. For example, you might ask students, "What did you like best and why? Did anything make you feel uncomfortable? What did you learn?

Talking to other teachers can also give you important feedback about your students and your teaching. If students are complaining about you to others, then you have a problem you might need to deal with. (Of course, teachers might not be able to share what students say in confidence, or they might not be willing to confront the issue with you.) You can also find out if students are excited enough about your environmental education activities to tell other teachers. And you can get other teachers' reactions to your students.

Talking to parents about specific issues regarding your environmental education program can also provide you with important feedback and support. Students often tell their parents things that they wouldn't tell you. By listening to parents, you can also determine how they feel about your environmental education activities, including community projects designed to improve environmental quality. Many teachers hold open houses and invite parents to speak informally about how their students are doing.

Peer and Self-Evaluation: Encouraging peer review is another important informal evaluation tool. Students can ask each other questions, critique each other's papers, evaluate group participation, and take part in a variety of other assessment activities. Although some students might be embarrassed at first, it starts working when students realize they are able to help each other catch mistakes and inconsistencies. This helps provide you with feedback, and it helps students think about their own performance. This can be especially effective with environmental education activities involving controversial issues and community action projects. (When using peer evaluation, it's important that you work with your students to understand how to evaluate each other's work fairly and give both positive and constructive comments.)

Self-evaluation is also an important informal assessment tool. By asking students how they think they are doing, you will often get surprising insights into your teaching. You can ask students to rate themselves on a variety of issues and explain where they need help.

Public Displays and Products: Art displays, essays, performances, posters, bulletin board displays, maps, and other activities and products can also help you develop student interest and motivation. For example, if you are teaching English and assign your students a poster project focusing on an environmental topic, you can tell a lot about what they're thinking and what they know. You can also tell how well students use the resources they have. You can also evaluate environmental action projects, such as stream clean-ups, and school habitat projects.

Outside Activities: Another way to evaluate the success of your program is to measure student activities outside the classroom. From observing their behavior when they leave school (Do they toss litter on the ground or sell wild animals?) to finding out if they are involved in environmental projects with church or community clubs, you can see if environmental education learning transfers to their personal lives.

Questionnaires: Asking students, parents, and others to fill out questionnaires can help you evaluate your program and/or teaching. When developing a questionnaire, it's important to know what type of information you are asking for and to design the questions to match your audience. Although questionnaires can take time to develop and evaluate, they allow you to get honest feedback that can help you improve your teaching. When developing a questionnaire, write clear, easy-to-understand questions that don't influence the respondent. (For example, questions that start with "Don't you agree that . . ." would "lead the witness.") It's also a good practice to include a mix of open-ended questions (What did you like best about the field trip and why?) and forced choices (Rate the unit on rain forests, using the following scale).

PORTFOLIO POWER: Many educators collect and organize their informal evaluations by keeping portfolios of student work and encouraging students to keep their own portfolios. Portfolios are folders of class assignments, writing, homework, observation checklists, notes, and whatever else you feel would help you evaluate your students. Students can also keep some of their projects and assignments in their own portfolios so they can measure their own progress and proudly show off the projects they've worked on. Depending on your teaching program, you might want to have separate portfolios to collect environmental education materials or information on environmental education projects. (In some countries, due to lack of materials and storage space, portfolios might not be practical. But you might be able to keep a record on each student in a notebook or binder.)

Note: With all evaluation, and especially with informal techniques, establish criteria that will help you determine how well your students are doing. For example, if you are evaluating class participation, you need to decide before you start what determines an acceptable performance, what you hope to learn from the evaluation, and how you will keep track of who said what. And if you are evaluating research papers, you might want to set up criteria based on how the information is organized, how well the facts are backed up by credible sources, and how well the material is presented. It's also important to check for your own biases when conducting informal evaluation to make sure that you don't "play favorites" when evaluating your students.

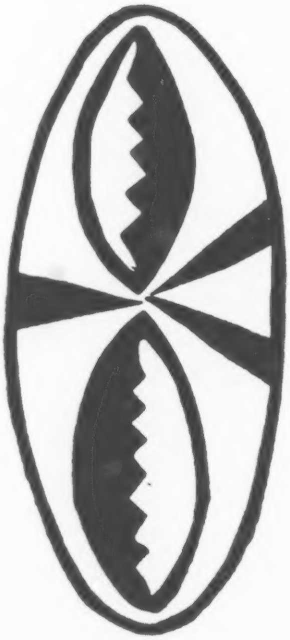
BUILDING ON BASELINE DATA

By using a combination of formal and informal, formative and summative evaluation, you can find out important information about your teaching and how much your students are learning. But how you actually design and conduct your evaluation will depend on what you are trying to measure, as well as the time, interest, resources, school requirements, and so on. In most cases, large classes, limited resources, and limited time will prevent you from spending a lot of effort developing an in-depth evaluation design. But it's important that you work evaluation into your program from the beginning, no matter what kind of evaluation program you use.

We recommend that no matter what type of evaluation you end up doing that you conduct an informal evaluation of your school and students at the beginning of the year, so that you have some baseline data to use for comparison later on. By jotting down notes about your students (their attitudes about school, how they feel about environmental problems, what they hope to learn in the upcoming year, and what knowledge and skills they already have) and your colleagues and administrators (how they feel about environmental problems and environmental education), you can gather some important information. (See the questions in Chapter 3 for ideas about what to find out.) This qualitative information can give you a feeling for whether student and teacher attitudes have changed over time with regard to environmental education, environmental problems, your teaching, and so on.

It is difficult to know if student learning is the result of your teaching or outside factors, including TV, parents, books, movies, and so on. Evaluation can help produce more effective education programs, but it can't tell you everything. Trusting your intuition and feelings about what is effective is an important part of a total evaluation picture.

It's also important to get feedback from the students throughout the year. Give them an opportunity to tell you how they feel about what they're learning and what parts of your class they like and don't like and why. This can help you adjust the course as you go and keep your students interested. You can hold informal interviews throughout the year with individual students or small groups or have the students fill out informal evaluations. It's important to evaluate as you go so that you can get timely feedback. And if you wait until the end of the year, your students might forget the specifics. Student evaluation can be very informal—at the end of a unit, ask the group to write down everything they liked about the last three weeks (including subject matter, teaching style, and so on), anything they didn't like, and anything they would change if they had to take the unit again. You can also have students fill out quick evaluations at the end of some classes, jotting down what they liked, what they didn't understand, and what they wished they had spent more time on.



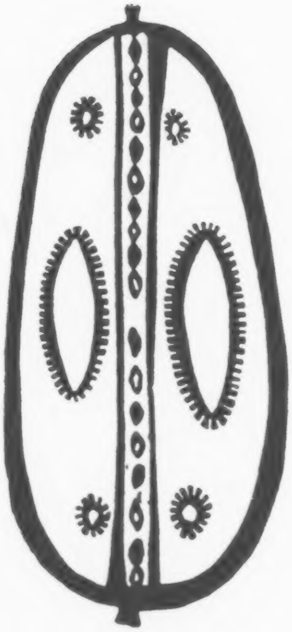
A Word About Grading and Testing

In some countries, you might be required to grade students in a way that you don't agree with or to "teach to the test" to help your students pass required standardized tests. It's important that you meet the requirements of your school and supervisors. But in some cases, you might be able to work with other teachers to help change a system you feel is overly rigid or ineffective. Some Volunteers, working in curriculum development units, have focused on incorporating more relevant questions into standardized testing, including more emphasis on the environment and other relevant topics. Many teachers are also working to increase the number of problem-solving questions and decrease the number of trivia-type questions.

It's important that you help your students do their best on standardized tests. But you don't have to forget about environmental education, even if it's not emphasized on the test. Use environmental education to help teach the objectives you are required to teach. For example, if you are teaching students how to conduct accurate measurements or figure percentages, use environmental content. (They can figure out the height of trees, sample insect populations, and figure out percentages by conducting community surveys.) If you are trying to improve reading and writing skills, use local newspaper articles focusing on environmental issues and other relevant and "real" content.

MEASURING ATTITUDE CHANGES

Although attitudes are an important component of environmental education, they can be tough to measure. Unlike knowledge and skills, you can't directly measure how students really feel about different aspects of the environment. How do you know for sure that a student values clean air or a healthy environment? It's also hard to know if attitudes translate into changed behaviors. How do you know that a student who vows to stop "wasting" energy will really cut back on energy use?



Although it is difficult to measure a person's attitudes and values, you can gather information that can help you find out how he or she feels. One way is by observing students' behaviors. For example, you can compare student behavior at the beginning of the year and at the end to see if there is a change. After teaching your class, do you notice that your students pick up litter, ask more questions about the environment, or get involved in community activities? Do they seem concerned about local and national environmental problems? Do they read more about environmental problems?

You can also give students a survey at the beginning of the year, asking how they feel about a number of issues and then resurvey after the course. For example, here are some ways to find out more about student values and attitudes:

1. OPINION POLLS

Give students statements about the environment and have them choose from several responses such as "totally agree, partially agree, disagree," or "strongly agree, agree, undecided, disagree, strongly disagree."

People that drive polluting cars should be fined.

2. RANKING

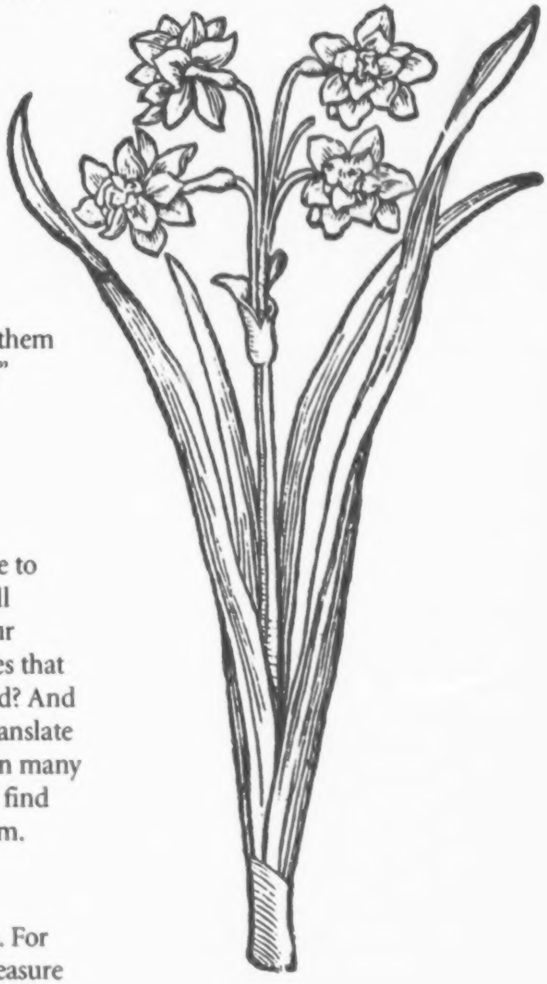
Rank the following list of environmental problems facing Chad by writing "1" next to the problem that you think is most urgent and "5" next to the least urgent. Explain your reasoning.

3. Value Continuum

Give students two attitude extremes and have them mark where they feel they are on the continuum. For example:

Wetlands are Worthless			Wetlands are Valuable	
1	2	3	4	5

Farmers should not use pesticides			Farmers should use pesticides as they need	
1	2	3	4	5



4. Action Survey

Ask students questions about their own behaviors and have them choose from responses such as "very often, often, seldom, never."

How often do you litter?

How often do you dump oil down the drain?

How often do you recycle?

Even though you survey your students, it's almost impossible to know if attitude changes that occur during a one-year course will continue after your students leave your class. For example, if your students say they are concerned about environmental issues, does that translate into responsible environmental behavior down the road? And if they take part in a clean-up during the school year, will that translate into community service and clean-ups after they leave school? In many countries around the world, researchers are tracking students to find out the long-term effects of an environmental education program.

5. Moral Dilemmas

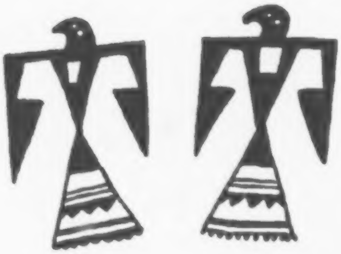
You can use moral dilemmas to assess moral reasoning skills. For example, Dr. Iozzi has developed a standardized instrument to measure moral reasoning by using a series of four moral dilemmas that are keyed to Kohlberg's stages of moral reasoning. For examples of moral dilemmas, see Chapter 7.

How to Use Evaluation to Gain Support for Your Program

As you begin to gather data about your teaching program and student successes, use the information to gain support for your programs. Think about what parents, community leaders, school officials, public agencies, government groups, colleagues, and Peace Corps staff might be interested in knowing and what they might do with the information. In some cases, just keeping people informed is important. If your students have been organizing a tree planting program, invite the community to a tree planting ceremony or write an article for the local newspaper explaining the project. Let parents and community leaders know how many trees were planted, how students organized the event, how grades improved (if they did), how student or teacher attitudes changed, and any other relevant information.

It's also important to keep your administrators and colleagues informed by sharing evaluation results with them—especially if environmental education is new and people are concerned it will take time away from more traditional subjects. By letting others see that environmental education can help teach already established objectives, they will be more apt to support your efforts in the future.

SUMMARY



Evaluation can let you know what you're doing right and where you need to improve. It can also help you discover unanticipated outcomes—both positive and negative—that result from your environmental education program. And it can provide you with insight about how to help your students become more environmentally literate. But remember that environmental education is a long-term process. You can't change your students overnight or expect them to think a certain way about the environment. What you can do is help students gain the knowledge, skills, and attitudes they will need to act in an environmentally responsible manner and help them realize that improving the environmental quality of their communities is in their own best interest.

There are many resources that can help you design and conduct an effective evaluation and help you figure out how to best use the informal and formal evaluation results to improve your program. Many of these resources also include more in-depth information about how to use formal and informal evaluation to fairly and effectively grade your students and how to design the most effective evaluation instructions. (See the Bibliography for a list of evaluation resources.)

QUESTIONS TO THINK ABOUT . . .

1. *Do you know what you want to evaluate and what you want to do with your evaluation results?*
2. *Is your testing reliable, valid, and useable?*
3. *Are you using a mix of formal and informal evaluation?*
4. *Do you know how you will collect and record your data?*
5. *Have you decided whom you will share your results with and how they will use the results?*
6. *Is the classroom environment conducive to learning?*
7. *Are you evaluating knowledge, skills, and attitudes?*
8. *Have you given your students an opportunity to evaluate your teaching?*

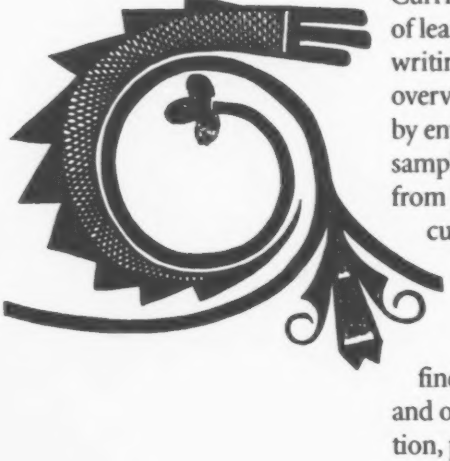
APPENDIX

Never does nature say one thing and wisdom another."

—Juvenal

In this section

we've included some additional information that can help you develop an effective environmental education program. The first section includes two sample lesson planning worksheets. Use these as samples to develop a planning process that works best for you. The second section includes a sample list of core thinking skills, developed by the Association for Supervision and Curriculum Development. The third section reviews the three domains of learning: cognitive, affective, and pychomotor, and includes verbs for writing cognitive objectives. The fourth section presents a very brief overview of a scope and sequence for environmental ethics, developed by environmental educator Bill Stapp. The fifth section includes two sample curriculum frameworks, one from the United States and one from the Asia/Pacific Region. And the final section looks at the goals of curriculum development, developed by Harold Hungerford, Ben Payton, and Rick Wilke, three environmental educators from the United States.



We also suggest that you use the Bibliography on page 481 to find out more about environmental issues, education, lesson planning, and other topics that interest you. And if you need additional information, please write to the Office of Training and Program Support, Environment or Education Sector, 1990 K Street, NW, Washington, DC 20526.

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1.

SAMPLE LESSON PLANNING WORKSHEETS

On these two pages, we've included two sample lesson planning worksheets. The first is a general lesson plan outline that includes space for the subject, topic, objectives, activities, materials, evaluation, and comments. The second example is from the 4MAT system. It includes space for the title, subject, date, evaluation, and comments. It also divides the activity portion of the lesson plan into four components: motivation, information, practice, and application.

Although there are many ways to plan lessons, most educators would agree that using a worksheet helps organize thoughts and that it's important to write down objectives, key questions, activities, and how to evaluate the lesson. It also helps to jot down comments about what worked and what didn't work and how you would do things differently the next time. For more about lesson planning, see Chapter 6.

GENERAL LESSON PLANNING WORKSHEET

SUBJECT:______________________________ **DATE:**__________

TOPIC: ____

OBJECTIVES:_____________________________________

ACTIVITIES/EXPERIENCE
(Brief description and time required)

QUESTIONS TO ASK:

MATERIALS:

EVALUATION:

COMMENTS:

4MAT LESSON PLANNING WORKSHEET

TITLE: ____________________ **DATE:** ____________________

SUBJECT: ____

APPLICATION:

MOTIVATION:

PRACTICE:

INFORMATION:

EVALUATION:

COMMENTS:

2.

CORE THINKING SKILLS

In this section, we've included a core thinking skills outline developed by the Association for Supervision and Curriculum Development (ASCD). It groups major thinking skills into eight headings: focusing skills, information-gathering skills, remembering skills, organizing skills, analyzing skills, generating skills, integrating skills, and evaluating skills. Although this is just one grouping, it might provide you with some ideas about how to incorporate thinking skills into your teaching program.

The following is reprinted from "Dimensions of Thinking: A Framework for Curriculum and Instruction" by the Association for Supervision and Curriculum Development.

Thinking skills are relatively specific cognitive operations that can be considered the "building blocks" of thinking. The following (1) have a sound basis in the research and theoretical literature, (2) are important for students to be able to do, and (3) can be taught and reinforced in school.

Focusing Skills: attending to selected pieces of information and ignoring others

1. Defining problems: clarifying needs, discrepancies, or puzzling situations
2. Setting goals: establishing direction and purpose

Information-Gathering Skills: bringing to consciousness the relevant data needed for cognitive processing

3. Observing: obtaining information through one or more senses
4. Formulating questions: seeking new information through inquiry

Remembering Skills: storing and retrieving information

5. Encoding: storing information in long-term memory
6. Recalling: retrieving information from long-term memory

Organizing Skills: arranging information so it can be used more effectively

7. Comparing: noting similarities and differences between or among entities
8. Classifying: grouping and labeling entities on the basis of their attributes
9. Ordering: sequencing entities according to a given criterion
10. Representing: changing the form but not the substance of information

Analyzing Skills: clarifying existing information by examining parts and relationships

11. Identifying attributes and components; determining characteristics or parts of something
12. Identifying relationships and patterns: recognizing ways elements are related
13. Identifying main ideas: identifying the central element; for example, the hierarchy of key ideas in a message or line of reasoning
14. Identifying errors: recognizing logical fallacies and other mistakes and, where possible, correcting them

GENERATING SKILLS: producing new information, meaning, or ideas

15. Inferring: going beyond available information to identify what may reasonably be true
16. Predicting: anticipating next events, or the outcomes of a situation
17. Elaborating: explaining by adding details, examples, or other relevant information

INTEGRATING SKILLS: connecting and combining information

18. Summarizing: combining information efficiently into a cohesive statement
19. Restructuring: changing existing knowledge structures to incorporate new information

EVALUATING SKILLS: assessing the reasonableness and quality of ideas

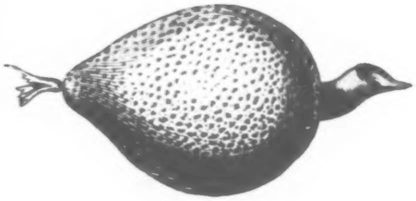
20. Establishing criteria: setting standards for making judgements
21. Verifying: confirming the accuracy of claims

> *Without a global revolution in the sphere of human consciousness, nothing will change for the better in the sphere of our being as humans, and the catastrophe toward which this world is headed—be it ecological, social, demographic, or a general breakdown of civilization—will be unavoidable.*
>
> —Vaclav Havel

3.

Bloom's Taxonomy

On these pages, we've included a brief overview of Bloom's three domains of learning: cognitive, affective, and psychomotor. We've also fleshed out the cognitive domain by including a list of verbs that correspond to each level. You can use these verbs to develop objectives for your lesson plans that focus on all levels of cognitive learning. For more information about the affective and psychomotor domain, please see An Introduction to Theories of Learning *by B. R. Hergenhahn (Prentice Hall, Inc., 1982),* Psychology, Teaching, Learning, and Growth *by Don Hamachek (Simon and Shuster, 1990), or Bloom's original research.*



Cognitive Domain

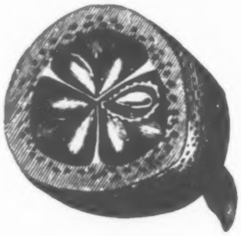
1. Knowledge
2. Comprehension
3. Application
4. Analysis
5. Synthesis
6. Evaluation

Affective Domain

1. Receiving
2. Responding
3. Valuing
4. Organizaton
5. Characterization

Psychomotor Domain

1. Reflect movements
2. Fundamental movements
3. Perceptual abilities
4. Physical abilities
5. Skilled movements
6. Nondiscursive communication



Verbs to use in writing objectives

The Cognitive Domain

1. **Knowledge:** defines, describes, identifies, labels, lists, matches, names, outlines, reproduces, selects, states
2. **Comprehension:** converts, defends, distinguishes, estimates, explains, extends, generalizes, gives examples, infers, paraphrases, predicts, rewrites, summarizes
3. **Application:** changes, computes, demonstrates, discovers, manipulates, modifies, operates, predicts, prepares, produces, relates, shows, solves, uses
4. **Analysis:** breaks down, diagrams, differentiates, discriminates, distinguishes, identifies, illustrates, infers, outlines, points out, relates, selects, separates, subdivides
5. **Synthesis:** categorizes, combines, compiles, composes, creates, devises, designs, explains, generates, modifies, organizes, plans, rearranges, reconstructs, relates, reorganizes, revises, rewrites, summarizes, tells, writes
6. **Evaluation:** appraises, compares, concludes, contrasts, criticizes, describes, discriminates, explains, justifies, interprets, relates, summarizes, supports

4.

ENVIRONMENTAL ETHICS: A SAMPLE SCOPE AND SEQUENCE

One of the things that makes environmental education unique is the focus on attitudes, values, and ethics. In this section, we've included a sample scope and sequence that focuses on environmental ethics from Environmental Education Activities Manual by William B. Stapp and Dorothy A. Cox, 1979. For more about environmental ethics and values, see Chapter 4.

UNDERSTANDINGS

A. LOWER ELEMENTARY

1. Children all over the world have similar basic needs.
2. Every individual has something that he or she gives and that he or she receives from society.

B. MIDDLE ELEMENTARY

1. If human beings protect the earth, it will be able to continue to support a diversity of living things.
2. Humans can be "stewards" of the earth, rather than careless exploiters of it.
3. Humans can develop both a way of thinking and feeling about the earth if we are to live harmoniously with each other and our environment.

C. UPPER ELEMENTARY

1. If humans develop an ecologically sound way of thinking, feeling, and acting toward the earth, then we will be able to live harmoniously with each other and our environment.
2. If we protect the earth it will continue to meet the needs of all living things, now and in the future.

D. MIDDLE SCHOOL

1. The earth's resources exist for all living things, not just people.
2. Certain life styles enable people to live as a complementary part of the environment.

E. SECONDARY SCHOOL

1. Only when each of us lives a life guided by respect for the earth and all living things, now and in the future, will we be able to live in harmony with each other and our environment.
2. An essential part of an environmental ethic is a human ethic based on social justice for all individuals and groups.

5.

SAMPLE ENVIRONMENTAL EDUCATION CURRICULUM FRAMEWORKS

In this section, we've included two sample environmental education curriculum frameworks. Each provides an outline of important concepts and topic areas for an environmental education program. The first is from "A Guide to Curriculum Planning in Environmental Education" by Dave Engleson (Wisconsin Department of Public Instruction, 1987), pages 14-22. The second example is from the "Sourcebook in Environmental Education for Secondary School Teachers" by R. C. Sharma and Merle C. Tan (Unesco Principal Regional Office for Asia and the Pacific, 1990), pages 174-180. For more about curriculum development, see Chapter 5.

SAMPLE CURRICULUM FRAMEWORK FOR WISCONSIN

There are fundamental environmental principles that provide a content dimension for a K-12 environmental education program. Presented in the outline form that follows, they provide an organized view of what an environmentally literate citizen should know about Earth's environments and how they function. The principles outlined below are dealt with in much greater detail in the environmental curriculum development monographs, companion volumes to this guide. Each of the monographs deals with a single element of Earth's environment or a serious threat to its operation.

This outline is based on that found in *Fundamentals of Environmental Education,* a 1976 report of the Subcommittee on Environmental Education, Federal Interagency Committee on Education.

FUNDAMENTAL PRINCIPLES DEALING WITH EARTH'S ENVIRONMENT

A. Earth's environment operates as a system supported by conditions that are functions of Earth's structure and place in the solar system.
    1. Solar energy is the primary source of energy for all physical, chemical, and biochemical cycles and other processes occurring on Earth.
    2. Nuclear processes, geothermal sources, tidal movements, and gravity are secondary sources.
    3. Earth is in a state of overall energy balance, absorbing energy from the sun and radiating it into place.
    4. Absorption and distribution of solar energy result in the movement of global air masses, the hydrologic cycle, and ocean currents, giving raise to Earth's prevailing weather and climates and providing conditions essential to life on Earth.

B. Earth's environment is a complex, interrelated, interactive, dynamic, constantly changing macrosystem called the ecosphere.
    1. The ecosphere is composed of a mosaic of interacting systems called ecosystems.
        a. An ecosystem is a recognizable, homogenous unit existing at a particular point in space and time, consisting of three groups of components: (1) physical (sun's energy, climate, rocks, water); (2) life forms (including humans); and (3) interactions between living and nonliving components (competition, erosion, decomposition).
        b. The characteristics of an ecosystem, derived from the interaction of its components, differ from the characteristics of individual components and can be understood only when studied as a complete functioning unit.
        c. Characteristics of a species of organism depend upon interactions of its generic composition with the environment.
        d. Ecosystem processes are limited by physiochemical attributes (energy, materials, space, time) and the inherited characteristics of organisms.
        e. These characteristics adapt a population of an organism to function in a particular role known as a niche. Populations of organisms are interdependent with one another and with their physical environment.

   f. Both ecosystems and species of organisms vary in their ecological amplitude, that is, their parameters and capacities to interact with other components of the ecosystem, and with other ecosystems.

2. The ecosphere has and is undergoing continuous change.
   a. Environmental factors, such as climate, topography, geologic processes, and the distribution of oceans and continents, have changed throughout Earth's history.

> *When we try to pick out something by itself, we find it hitched to everything else in the universe.*
>
> —John Muir

   b. Organisms have changed greatly through many small consecutive modifications of their genetic composition, thus adapting to a changing environment. Organisms that have failed to adapt have become extinct.
   c. New ecosystems are created as organisms invade formerly lifeless water or bare mineral substrates (such as rock), or as existing ecosystems are modified.
      - New combinations of organisms and environments produce new ecosystems.
      - Interactions of living and nonliving components change the character of an ecosystem.
      - Natural and human processes, for example, fires, landslides, earthquakes, and urbanization, alter ecosystems in varying degrees.
      - Ecosystems have various degrees of resiliency to alteration, giving them varying capacities and rates of recovery from alteration.
      - Ecosystems can be reduced to near or actual extinction by the removal or addition of components and the change of processes, but unless the area is rendered toxic to all life for extended periods, a new ecosystem subsequently will develop.
   d. As ecosystems persist and mature over time, there is a tendency toward an increase in the diversity of organisms.
      - Mature ecosystems have a steady-state character even though individual organisms and species arrive, die, or depart, and even though particular kinds of organisms may not always be present.
      - Mature ecosystems tend to be very stable, with more resilience to physical, biological, economic, and social variations than developing systems.
   e. Niches become more specialized as ecosystems mature.
      - Niche specialization occurs when ecosystem changes interact with organism changes.
      - Niches can be expanded if species learn new behaviors, thus enabling more types of organisms to live in an ecosystem and further modify its character.
   f. Some ecosystem characteristics are influenced strongly by the origin and history of the ecosystem.
3. Energy and materials required for life pass into or are found in the ecosphere, and are components of each ecosystem.
   a. Ecosystem energy comes originally and primarily from the sun; materials come from components of the ecosphere.
   b. Green plants, through photosynthesis, use solar energy to convert water, carbon dioxide, and small amounts of minerals into high energy organic compounds that power all life processes.
      - The process of respiration releases this energy in other organisms.
      - The processes of photosynthesis and respiration are limited to a narrow range of temperatures, moisture, and chemical conditions, and by the genetic composition of organisms.
   c. Materials are cycled and recycled through ecosystems via pathways known as food webs. In food webs materials pass through plants, through herbivores, and through carnivores. At any of these three levels, decay organisms may reduce organic matter to inorganic, thus completing the cycle.

d. Some energy moves through physical and chemical components of ecosystems; the rest through food webs.
   - Energy conversions are never 100 percent efficient, so energy is constantly dissipated from the system, resulting in a deficit.
   - A constant infusion of energy from the sun is required for organisms and ecosystems to live and to grow.
   - Some energy is stored in organic materials and is available for future use.

e. Most natural ecosystems are adapted to operate on the energy and materials directly available to them. These resources are renewable through recycling.
   - In natural ecosystems the rates of consumption and renewal are balanced.
   - In ecosystems containing primitive human social groups, these rates are also balanced.
   - In ecosystems containing modern human social groups, there is a demand for heavy subsidization of energy and materials.

4. Each ecosystem of the ecosphere contains a number of species populations, the size and stability of which vary, depending on biotic and abiotic changes in the system.

   a. A population introduced into an ecosystem to which it is adapted shows a typically s-shaped pattern of growth as births exceed deaths, a leveling off as the rates equalize, and a decline as the death rate exceeds the birth rate.

   b. Population, birth, and death rates are influenced by intrinsic and extrinsic limiting factors.
      - Intrinsic factors are genetic and include reproductive capacity, innate behavior, food requirements, and resiliency.
      - Extrinsic factors are environmental and include chemical factors, such as nutrients and toxins; physical factors, such as temperature and humidity; and factors related to interactions with its own and other populations, such as competition, predation, parasitism. Population density affects all extrinsic relationships.
      - The modern human birth rate is affected primarily by socio-cultural means, for example, delay in marriage, contraception, abortion; the death rate by technology, for example, medical science, sanitation, dietary improvement. The net result of recent changes in both rates has been a substantial increase in the size and growth rate of Earth's human population.

   c. Population size in an ecosystem will vary over time with changes in physio-chemical factors and with biological interactions, thus defining a carrying capacity of the ecosystem for a population under a given set of conditions. Within finite limits, technology can increase an ecosystem's carrying capacity.

   d. Spatial arrangements and total numbers of individuals in a population are equally important in ecosystem functioning.

   e. Population distribution is controlled by ecological amplitude, environmental barriers to dispersal, and history.

FUNDAMENTAL PRINCIPLES DEALING WITH HUMANS AS ECOSYSTEM COMPONENTS

A. Humans use ecosystems to satisfy basic needs and desires.

   1. Basic biological needs that must be met for humans to live and grow include habitable climate, energy, materials, rest and exercise, other humans for reproduction, and protection against environmental stresses.

   2. Humans cannot grow and completely develop mentally unless essential psychological and social needs and desires are met. These include security,

love, esteem, self-fulfillment, social interaction, health, comfort, material goods, and religious experiences.

3. Each human culture has its own perceived needs and desires that make different demands and impacts on ecosystems. In times of stress many of these needs and desires can be adjusted.
   a. Culturally specific perceived needs include:
      - preservation of land, ecosystems and species, and the conservation of materials and energy;
      - satisfaction of desires for status and for exotic materials and experiences;
      - economies of scale concentrating human activities that result in major ecosystem changes;
      - planned obsolescence of manufactured goods; and
      - dietary customs, family size, and work attitudes.
   b. Universal human desire for increasing amounts of material goods is expressed differently in different cultures. The human impact on ecosystems increases as these desires are satisfied.
   c. Value systems are an important factor in determining the kind and extent of a society's impact on ecosystems.
   d. Increasing the consumption of energy and materials often leads to deleterious impacts on ecosystems such as:
      - increased CO_2 and heat in the atmosphere, resulting in heat islands over cities;
      - changes in the reflective power of Earth;
      - introduction of synthetic substances that may be toxic, mutagenic, or carcinogenic.
   e. Concentration of humans in built environments intensifies the deleterious effects of humans on ecosystems.

B. Humans are an all-pervasive species in the ecosphere and thus exert a special ecological dominance.
   1. Human domination results from various factors.
      a. Intellectual capacities permit the development of:
         - technology, giving unique control over energy flow, food and goods production, disease, and other factors that could limit human populations;
         - unique institutional and technological control over other populations in ecosystems such as the domestication of species, suppression of undesirable species, and the encouragement of desirable species.
      b. Biological and cultural adaptation to a wide range of environmental conditions may result in either positive or negative effects.
      c. Sheer population size results in domination.
      d. Specialization and diversity in the division of labor allows for domination.
   2. Human tendencies to form and function in social and corporate groups and institutions promote development of human habitats that create unique concentrated demands on ecosystems and further increase human effects on ecosystems.
      a. These effects are intensified by the concentration of humans in small areas.
      b. The effects of human settlements on a metropolitan scale on ecosystems rival those of mountains, glaciers, droughts, and floods.
   3. Recent rapid increases in human populations and technological capabilities have accelerated ecosystem changes until some are potentially irreversible.
   4. Human aesthetic, ethical, moral, and spiritual values may reinforce or conflict with harmonious relationships within ecosystems.

C. Ecosystems affect humans
   1. Humans and all their products function in an ecosystem framework.

The environment is not only more complex than we think; it is more complex than we can think.

– Unknown

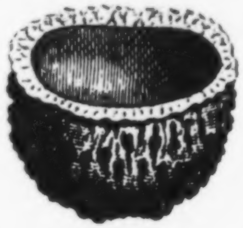
    a. Built environments radically transform human societies and cultures.
    b. Past ecosystem processes and events have produced major biological and cultural differences in human populations.
2. Ecosphere changes due to increasing human population and technology have both short and long term effects.
    a. Short term effects include changes in:
        - birth and death rates;
        - biological fitness of human populations as measured by growth rates, disease patterns, nutritional levels, and aging;
        - use of nonrenewable material and stored energy resources; and
        - functional capacities of individuals and populations, for example, mental productivity and attitude.
    b. Long term effects include changes in:
        - genes and chromosomes and their evolutionary consequences;
        - elimination or introduction of selection pressures;
        - ecosystems due to evolution of component populations;
        - health and life cycles;
        - global climate;
        - reserves of nonrenewable and renewable resources; and
        - culture.
3. The built environment and its psychological milieu have a powerful effect on humans. Information transfer by verbal communication and learned behavior operates on humans in a parallel and synergistic manner in much the same way as do physical and chemical components of ecosystems.

D. Complex interactions among humans and other ecosystem components occur continuously.
1. Humans' perceptions of their needs, their impacts on ecosystems, and ecosystem impacts on them reflect the cultural and individual values, goals, skills, insights, and capabilities of the individuals, groups, institutions, and nations involved.
2. Relationships among components of ecosystems are reciprocal, ranging from mutually beneficial to unidirectionally destructive.
3. Feedback mechanisms of different kinds, for example, physical, chemical, social, and behavioral, ranging from rudimentary to highly sophisticated, govern relationships among and within components of ecosystems.
4. Human activities often have synergistic effects on ecosystems and vice versa.
5. Human activities affect ecosystem maintenance and management.
    a. Potentially positive activities of humans within ecosystems include:
        - domesticating plants and animals;
        - reducing of disease and mortality;
        - constructing and controlling space for living, working, manufacture, storage, recreation, and transportation;
        - preserving genetic stocks of nondomesticated organisms and preservation of specific ecosystems;
        - appreciating ecosystems and their components;
        - developing human law and property rights;
        - reducing human populations under certain social-cultural conditions; and
        - elaborating functional roles for humans, which increases diversity of ecosystems.
    b. Potentially destructive activities of humans within ecosystems include:
        - bringing on large scale events (such as oil slicks, floods, atmospheric changes) that warn of imbalances between human activities and ecosystem functions;
        - reducing the number of individuals in a species; interrupting the continuity of reducing the area of ecosystem types and reducing the average species diversity for a given ecosystem type;
        - increasing environmentally-related human health problems, such as pollution-induced disease, noise-induced deafness;

- deliberately or inadvertently destroying or modifying habitats;
- creating and concentrating pollutants;
- dissipating energy and producing pollutants at high rates in urban areas;
- depleting relatively concentrated sources of raw materials.

METHODS FOR HARMONIZING HUMAN ACTIVITIES WITH ECOSYSTEM PROCESSES TO ACHIEVE ENVIRONMENTAL QUALITY

> *If human beings were to disappear from earth, the other species of plants and animals would be largely unaffected; if the other plants and animals were to disappear, however, human beings would disappear as well.*
>
> —Bruce Wallace



A. Methods by which human activities, local through global, are harmonized with ecosystem processes are complex, and outcomes are not always predictable.
   1. Barriers to harmony include:
      - inevitable, continuing, and largely unmanageable effects of ecosystem changes on human biology and culture;
      - incomplete or unavailable detailed knowledge needed to make environmental predictions;
      - lack of uniformly dependable social-political processes for responsible decision making.
   2. Harmony can be pursued through:
      - formal and nonformal education of the public;
      - practice of various art forms to develop human sensitivity to and appreciation of environmental quality;
      - encouragement of corrective actions by individuals, business and industry, citizen organizations, and government agencies;
      - voluntary adoption and implementation of policies and standards;
      - establishment of formal policies, guidelines, and standards;
      - use of economic and social incentives;
      - enforcement of policies, guidelines, and standards.
   3. Institutions, processes, and attitudes for promoting harmony include
      - education and communication;
      - religious, aesthetic, ethical and moral influences;
      - science and technology;
      - civic and social institutions;
      - government and political processes;
      - industry and commerce.

B. Basic procedure for harmonizing human activities with ecosystem processes.
   1. Investigate ecosystem processes and components, including the effects of human activities on ecosystems and the influences of ecosystems on human functioning.
   2. Recognize the importance of ecosystem processes and the significance of ecosystem changes.
   3. Identify the causes of ecosystem changes and their consequences.
   4. Develop alternative action strategies to maintain and enhance beneficial ecosystem changes and to reduce detrimental changes, with special attention to irreversible changes and to long range versus short range commitments of resources.
   5. Analyze and evaluate alternative action strategies within a broad array of environmental, social, and economic criteria, recognizing that criteria will differ according to circumstances of politics, geography, scale, time, and society.
   6. Select among alternative action strategies, and adopt a policy which can be implemented at all levels, individual through global.
   7. Decide on and complete actions to implement the policy.
   8. Monitor and evaluate effects of the implemented policy.
   9. Feeding information gained in step 8 back through step 1 to adjust actions to changing data bases, requirements, conditions, and perceptions.

SAMPLE CURRICULUM FRAMEWORK FROM THE UNESCO REGIONAL OFFICE FOR ASIA AND THE PACIFIC

> *Environmental degradation in all its forms is everybody's business: its control will require a massive mobilization of public, administrative, and scientific concern.*
>
> – Rene J. Dubois

The EE Programme is designed to enable students to:

1. Acquire basic understanding of the interrelationships of components and factors of the environment and the processes that occur in it.
2. Develop desirable values and attitudes, especially concern and responsibility toward the conservation and enhancement of the environment.
3. Acquire and refine skills in identifying, assessing, and solving environmental problems.
4. Develop a sense of urgency in responding to environmental issues and problems and taking action toward their solution.

BASIC ECOLOGICAL CONCEPTS

1. Human is an important part of the ecosystem. He/she must understand how the components of the ecosystem interact and depend on each other.
2. Nature has its own way of maintaining environmental equilibrium.
3. Human's culture including his/her technological activities create imbalance in the ecosystem.
4. To restore balance in nature, human has to reassess her/his attitude, behavioural patterns and ethical standards.
5. Some currently accepted values are in conflict with existing responsible environmental actions/campaigns.
6. Individuals, government and non-governmental agencies, national and international, must work for sustainable development to reduce depletion of resources and reduce environmental problems.

ENERGY FLOW IN THE BIOSPHERE

1. Energy is transferred from producers to primary consumers, then to secondary consumers in a food web.
2. The sun is the primary source of energy that supports life on earth.
3. Plants convert solar energy to chemical energy.
4. The shorter the chain, the less energy is wasted.
5. Toxic substances can be transported through the food chain and eventually reach human.
6. Safety measures in the use of pesticides, insecticides, and herbicides, and the proper disposal of household and industrial waste and other toxic substances should be looked into.
7. Energy cannot be created nor destroyed but it can be transformed from one form to another.

ENERGY UTILIZATION

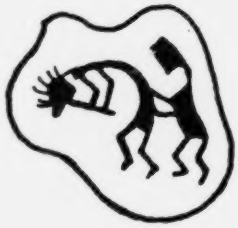
1. Energy shortage causes various socio-economic and political problems.
2. Countries need energy for development and progress.
3. Energy must be used wisely used (at home, in commerce, and in industry).
4. In the extraction and use of energy, pollution of the environment may occur.
5. More research should be done to reduce energy costs and to find alternative and indigenous sources of energy such as biogas, biomass, solar, wind, geothermal, and energy from waves.

POLLUTION

1. Pollution refers to adverse changes in the environment which affect biotic and abiotic components.
2. Pollution is a problem associated with development activities, and may be the price paid for progress.

3. The main channels of global pollution are air and water.
4. Pollution results in damage to vegetation, animal lives, human lives and man's property.
5. Different pollutants come from a variety of sources.
6. The accumulation and dispersal of pollutants are affected by meteorological conditions as well as socio-economic factors.
7. Indiscriminate use and mismanagement of water resources due to human's selfish motives have resulted in global water pollution.
8. Pollution control requires multi-sectoral participation. The participation/action of each individual increases the probability of success of any pollution control programme.

> *The universe is so successful, I simply want to learn its principles and apply them rather than to exploit it blindly and fear for survival.*
>
> – R. Buckminster Fuller



POPULATION

1. Population growth is self-regulating. Regulation is determined by the carrying capacity of an ecosystem.
2. Human can raise the carrying capacity of the environment by applying science and technology principles only up to a certain level.
3. Technological activities have an impact on the population of human and non-human species.
4. Human has developed techniques to alter genetic composition.
5. Population of the world is increasing at an alarming rate.
6. Population growth is influenced by physical, biological and socio-cultural factors.
7. Population density is generally higher in developing and underdeveloped countries then in developed countries.
8. Overpopulation brings about environmental and socio-economic problems as it increases the demand on the resource base.
9. The need for population control is dictated by the present world population situation and the carrying capacity of the environment.
10. All living organisms are interdependent.
11. Current value systems need to be reassessed.
12. Population growth can be controlled naturally or by artificial means. Population control depends on well defined policies and regulatory measures.
13. Cities represent a highly dense ecosystem.
14. The continuous migration of rural people to urban communities (urbanization) creates environmental problems. There is an urgent need to plan measures to improve the quality of life of rural people.
15. Urban communities have a greater demand for the basic human needs such as food, water, air, clothing, housing, health services and transportation services, and education.
16. Population problems can be reduced through a multi-sectoral approach.

BASIC NEEDS

1. To live we need air, water and food.
2. We need to take in oxygen from the air.
3. Oxygen is released by green plants during the process of photosynthesis.
4. Planting greenery helps to purify the air.
5. Green plants need water and energy, among other factors, in order to manufacture food.
6. The natural sources of fresh water on earth are surface water and underground water.
7. Surface water such as in rivers and lakes originates from watershed forests.
8. Underground water is tapped by the construction of wells.
9. Dams are built to store water for use when needed.
10. Water needs to be purified before it is taken in by the human body.
11. In addition to water, human obtains other sources of food through agricultural practices.
12. To increase the yield of food, human uses fertilizers and pesticides.

13. The misuse of fertilizers and pesticides affects human health and degrades the environment.
14. Some kinds of food have to be processed and preserved before they are transported to the consumers.
15. The preservation of food through the use of chemical additives might be hazardous to health.
16. To live clean and healthy, human should preserve the quality of air, water and food.

HEALTH AND ENVIRONMENT

1. Health hazards caused by noise, air, water, solid and toxic waste pollution leads to:
    - Impairment of hearing;
    - Formation of smoke and smog which cause respiratory problems;
    - Food poisoning and diseases due to contaminated food;
    - Formation of acid rain which affects cultivation of food crops;
    - Contamination of water supply due to dumping of industrial toxic wastes.
2. Health hazards caused by overpopulation include:
    - Poor sanitation and ventilation due to bad housing conditions;
    - Poverty and malnutrition.
3. Deforestation leads to a reduction in the supply of herbal medicines and thereby affects medical research.

NATURAL RESOURCES

A. Forest Resources

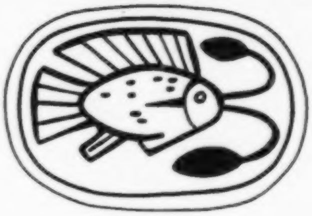
1. Forest resources are useful in many ways. They:
    - Are sources of fuel, building materials, medicine
    - Are habitats of wildlife
    - Help regulate CO2/O2 in air
    - Provide watersheds
    - Help maintain rainfall
2. The destruction of tropical forests to obtain fuel and building materials to utilize the land for growing crops and other developments such as building industries, houses, roads, dam, etc., would causes:
    - Soil erosion
    - Imbalance of CO2/O2 in the air
    - Reduction of rainfall
    - Flooding
    - Extinction of species (wildlife)
    - Displacement of inhabitants living in the surrounding affected areas
3. The clearing of mangrove forests for fuel, building materials and commercial fresh water farming causes the destruction of the ecosystem, the inundation of the shoreline/inland area and the reduction of food supply.
4. Planting of trees can help:
    - Prevent soil erosion
    - Regulate CO_2/O_2 in the air
    - Cool the surrounding area

B. Water Resources

1. There are several sources of water:
    - Lakes
    - Rivers
    - Ponds
    - Reservoirs
2. Water is essential to sustain life.
3. Water is used in:
    - Agriculture
    - Industries

    - Generating hydroelectric power
    - Domestic and recreational activities
4. The demand for usable water is increasing due to the rapid growth of population and industrial development.
5. The quantity and quality of water resources are affected by the way human uses water.
6. Water resources must be managed intelligently through:
    - Reducing water use;
    - Maintaining and preserving watersheds:
    - Controlling water pollution;
    - Recycling water.

> *The object of our game with nature is not to win, but to keep on playing.*
>
> – Unknown



C. Marine Resources

1. Marine resources constitute one of the world's principal renewable resources.
2. They are the only natural resource based on the productivity of the ecosystem.
3. They include marine fishes and other organisms in the seas and oceans, and the estuarine or coastal fishes and organisms.

Marine Fishery

4. There is a direct and an indirect utilization of the marine ecosystem.
    - The direct use is the harvesting of fish, marine mammals and other organisms (Fishery).
    - The indirect use is the oceans' role in determining climate, producing O_2 and diluting wastes (Ocean).
5. There are conflicts between fishery use and ocean use of the marine ecosystem.
    - They exist mainly in the areas of:
        - Transportation via ships, boats, tankers and supertankers;
        - Mining and dredging of the seas;
        - Waste disposal and pollution;
        - Oil exploration and production.
    - Overexploitation of marine fishes and mammals leads to depletion of (food) resources. Economic losses occur and fishers (and consumers) face food demand-supply problems.
    - Industrial pollution causes health hazards. Examples like Minimata and Itai-itai in Japan and red tides almost everywhere are causes for concern. Diseases and sometimes death do occur.
    - Nations impose 200 mile limits to conserve their own marine resources. This has led to disagreements or disputes among nations over national boundaries.

Estuarine Resources

6. Where the salty seawater meets the fresh riverwater abundant plant and animal organisms thrive —-estuarine resources.
7. Rivers supply rapid replenishment of plant nutrients to the estuarine ecosystem.
8. Estuarine resources may be divided into mangrove forests and aquatic inhabitants.
9. Mangrove Forests.
10. Aquatic Organisms:
    - Common aquatic organisms in an estuarine ecosystem are fish, crustaceans and mollusks.
    - These are part of the food chains of the estuarine ecosystem.
    - Nutrients come from the estuarine waters themselves.
11. Problems in estuarine areas include the following:
    - Depletion of mangrove trees/forests;
    - Overexploitation of estuarine resources;

- Pollution from up-river or pollution from the sea are washed up during high tides;
- Use of estuarine areas for drainage and development due to pressures from an expanding population nearby.

D. Wildlife Resources
1. Wildlife is important for maintaining the balance of ecosystems and the preservation of our cultural heritage and as a source of valuable information for scientific studies.
2. Conservation of wildlife, especially endangered species, has ecological, aesthetic, socio-cultural and ethical implications.
3. Endangered wildlife species can be conserved through proper management of their habitats and adequate control mechanisms.
4. Wildlife sanctuaries are oftentimes destroyed by indiscriminate destruction of forests through logging, burning and poor agricultural practices.

E. Soil Resources
1. Soil, usually taken for granted, is a natural resource, the most important function of which is to support plant life.
2. The ability of the soil to support the growth and development of plants depends on soil condition, the quality of the plants and climatic conditions.
3. Aside from food taken from plants grown in soil, plants provide life-sustaining oxygen, forest products like wood, natural fibres and native fuels.

Soil is made up of inorganic substances from parent rocks which have undergone several physical and chemical changes, together with organic substances from decomposed plant and animal remains.

5. Fertile soil lost through thoughtlessness of people and through erosion resulting from clearing of forests and mining activities could take centuries to be retrieved.

CORRECTIVE MEASURES

1. All types of pollution may be reduced through:
   - Proper enforcement of laws;
   - Increase public awareness of environmental issues through information campaigns and mass media;
   - Public participation in environmental management activities.
2. Overpopulation can be controlled by:
   - Proper family planning;
   - Proper housing and town planning.
3. Deforestation can be controlled by:
   - Proper enforcement of forestry and laws;
   - Recycling of wood products;
   - Optimizing land use by integrated farming method.

6.

Goals for Curriculum Development in Environmental Education

This last section lists the four major goal levels identified by Harold Hungerford, Ben Peyton, and Richard Wilke in 1980 to guide curriculum development and research in environmental education. They also noted that environmental sensitivity is a prerequisite goal for environmental education and can help students investigate environmental issues, evaluate alternatives, take part in actions that help improve environmental quality, and develop a personal environmental ethic. Taken together, these goals encompass the 5 components of environmental education: awareness, knowledge, skills, attitudes, and participation.

Goal Level I: The Ecological Foundations Level

This level seeks to provide learners with sufficient ecological knowledge to permit him/her to eventually make ecologically sound decisions with respect to environmental issues. The Ecological Foundations level would minimally include the following conceptual components:

A. Individuals and populations.
B. Interactions and interdependence.
C. Environmental influences and limiting factors.
D. Energy flow and nutrient cycling.
E. Community and ecosystem concepts.
F. Homeostasis.
G. Succession.
H. Humans as members of ecosystems.
I. The ecological implications of human activities and communities.

Goal Level II: The Conceptual Awareness Level/Issues and Values

This level seeks to guide the development of a conceptual awareness of how individual and collective actions may influence the relationship between quality of life and the quality of the environment and, also, how these actions result in environmental issues that must be resolved through investigation, evaluation, values clarification, decision making, and finally, citizenship action. Goals at this level are formulated to provide opportunities for learners to conceptualize:

A. how human cultural activities (e.g., religious, economic, political, social, etc.) influence the environment from an ecological perspective
B. how individual behaviors impact on the environment from an ecological perspective
C. a wide variety of environmental issues and the ecological and cultural implications of these issues
D. the alternative solutions available for solving environmental issues and the ecological and cultural implications of these solutions
E. the need for environmental issue investigation and evaluation as a prerequisite to sound decision making
F. the roles played by differing human values in issues and the need for personal values clarification as an integral part of environmental decision making
G. the need for responsible citizenship action in resolving environmental issues

Goal Level III: The Investigation and Evaluation Level

This level provides for the development of the knowledge and skills necessary to permit learners to investigate environmental issues and evaluate alternative solutions for solving these issues. Similarly, values are clarified with respect to these issues and alternative solutions. Goals at this level are presented in two components.

Goals for Component A are to develop in learners:

A. the knowledge and skills needed to identify and investigate issues and to synthesize the gathered information
B. the ability to analyze environmental issues and the associated value perspectives with respect to their ecological and cultural implications
C. the ability to identify alternative solutions for specific issues and the value perspectives associated with these solutions

D. the ability to evaluate alternative solutions and associated value perspectives for specific issues with respect to their cultural and ecological implications
E. the ability to identify and clarify their own value positions related to specific issues and their associated solutions
F. the ability to evaluate, clarify, and change their own value positions in light of new information.

Goals for component B are to provide learners with opportunities to:
G. participate in environmental issue investigation and evaluation
H. participate in the valuing process in a manner as to permit the learner to evaluate the extent to which his/her values are consistent with the super ordinate goal for environmental education

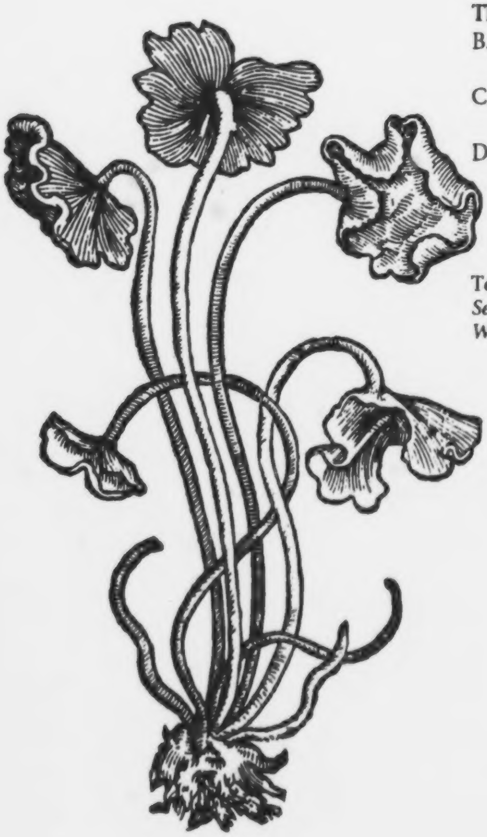
> *"We cannot change others, but when we change ourselves, we may end up changing the world"*
>
> – Melodie Beattie

GOAL LEVEL IV: ACTION SKILLS LEVEL—TRAINING AND APPLICATION

This level seeks to guide the development of those skills necessary for learners to take positive environmental action for the purpose of achieving and/or maintaining a dynamic equilibrium between quality of life and the quality of the environment. Goals at this level are presented in two components.

The goal for Component A is to develop in learners:
A. those skills that will permit them to effectively work toward ends that are consistent with their values and take either individual or group action when appropriate

The goals for Component B are to provide learners with opportunities to:
B. make decisions concerning action strategies to be used with respect to particular environmental issues
C. apply action skills to specific issues, i.e., to take citizen action on one or more issues
D. evaluate the actions taken with respect to their influence on achieving and/or maintaining a dynamic equilibrium between the quality of life and the quality of the environment



Adapted from "An Environmental Education Approach to the Training of Elemenatary Teachers: A Teacher Education Programme" *(UNESCO-UNEP, Environmental Education Series, #27) and* Environmental Education Teacher Resource Handbook *edited by Richard Wilke (Kraus International Publications, 1993).*

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You cannot open a book without learning something.

—Chinese Proverb

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If you chase two hares, you won't catch either one of them.

—Russian Proverb

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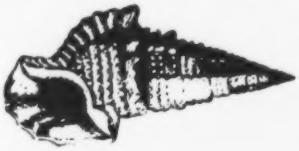

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Nature is the common universal language, understood by all.

—Kathleen Raine

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PROJECT LEARNING TREE developed by the Western Regional Environmental Education Council and the American Forest Council. A national environmental education activity series for educators with an emphasis on trees, forests, and general environmental issues. Includes two separate guides: one for primary educators, with 89 activities, and one for secondary educators, with 88 activities. Materials are available only by attending a Project Learning Tree Workshop. The current activity guides are being revised, with new materials scheduled for publication in 1993. For more information write to Project Learning Tree, 1250 Connecticut Avenue, NW, Washington, DC 20036.

PROJECT WILD/AQUATIC WILD developed by the Western Regional Environmental Education Council (WREEC). A national environmental education activity series for educators with an emphasis on wildlife. Includes a primary and secondary guide, plus a special guide on aquatic activities. Materials are available only by attending Project WILD workshops. Please write to Project WILD, Salina Star Route, Boulder, CO 80302.

NATURESCOPE INDIA: AMAZING MAMMALS written and adapted by Mamata Pandya (Centre for Environment Education, 1991). Includes a variety of mammal-related activities and background information for primary and middle school educators in Asia. Beautiful artwork and cover design. Shows how material from one country can be adapted for use in another. (This issue was adapted from *NatureScope: Amazing Mammals*, published by the National Wildlife Federation.) Write to the Centre for Environment Education, Thaltej Tekra, Ahmedabad, 380 054 for information about how to order this issue and other environmental education materials they produce.

OBIS (OUTDOOR BIOLOGY INSTRUCTIONAL STRATEGIES) developed by Lawrence Hall of Science, University of California, Berkeley, CA 94720 and published by Delta Education. Includes a collection of outdoor activity cards about a variety of natural history and science topics, from water striders to rocks. To order write to Delta Education, 5 Hudson Park Drive, Hudson, NH 03051.

OUTREACH: A NETWORK FOR ENVIRONMENT AND HEALTH AWARENESS TEACHING, TRAINING. A coalition of local, national, and international organizations working to disseminate information on environmental and health issues. Publications include magazines for children, articles for national and local newspapers, radio scripts, and more. Sponsored by the United Nations Environment Programme (UNEP), International Union for Conservation of Nature and Natural Resources (IUCN), New York Zoological Society (NYZS), World Wide Fund for Nature (WWF), and Television Trust for the Environment (TVE). Write to Dr. James Conner, OUTREACH Director, Department of Teaching and Learning, 200 East Building, New York University, 239 Greene Street, New York, NY 10003.

RANGER RICK'S NATURESCOPE edited by Judy Braus (National Wildlife Federation, 1984-1990). An environmental education activity series. Each issue includes background information, environmental education activities, and resources about a variety of topics including pollution, wetlands, oceans, birds, insects, geology, astronomy, endangered species, and deserts. Write to the National Wildlife Federation, 1400 Sixteenth St. NW, Washingon, DC 22036.

PREPARING FOR TOMORROW'S WORLD: DECISIONS FOR TODAY AND TOMORROW by Lou Iozzi and Peter Bastardo, published by Supris West, Inc., 1987. Contains a series of science-technology-society modules that focus on topics such as genetic engineering, nuclear energy, acid precipitation, and hazardous waste. Includes questioning strategies, background information, and case studies. Write to Sopris West, Inc., 1140 Boston Avenue, Longmont, CO 80501 for information about how to order.

Sharing Nature With Children by Joseph Cornell (Ananda Publications, 1984). A small paperback book that contains dozens of simple activity ideas to help students learn about and appreciate their environment. Write to Ananda Publications, Nevada City, CA 95959.

Thinking Globally and Acting Locally: Environmental Education Teaching Activities by Lori Mann and William Stapp (ERIC, 1982). The 17th Volume in the ERIC/SMEAC's "Teaching Activities in Environmental Education." This activity guide focuses on global environmental issues such as food production and distribution, energy, transportation, solid waste, endangered species, and lifestyle and environment. To order this guide or a catalog of environmental education materials, write to the ERIC Clearinghouse for Science, Mathematics, and Environmental Education, the Ohio State University, 1200 Chambers Road, Third Floor, Columbus, OH 42212.

General Environmental Education Resources

Avoiding Infusion Confusion: A Practical Handbook for Infusing Environmental Activities into your Classroom by H. Hayden, M. Oltman, and R. Thomson-Tucker (Central Wisconsin Environmental Station, 1987). Includes a variety of environmental education activities that can be infused into art, health, language arts, science, and social studies. The resources are organized into content areas.

Earth Education: A New Beginning by Steve Van Matre (The Institute for Earth Education, 1990). A controversial look at alternatives to help people improve their "cognitive and affective relationship with the earth's natural communities and life support systems." Includes discussions explaining why the Earth Institute feels environmental education is not currently effective, why supplementary materials are not the way to go, and where the field should be headed. Write to The Institute for Earth Education, Box 288, Warrenville, IL 60555.

Environmental Interpretation by Sam H. Ham (North American Press, 1992). An innovative and practical guide to interpreting the natural environment, with case studies and useful tips for anyone working in nonformal environmental education. Available in Spanish and English. Write to North American Press, 350 Indiana Street, Golden, CO 80401.

Environmental Literacy: Its Roots, Evolution, and Directions in the 1990s by Charles E. Roth, Education Development Center (ERIC, 1992). Discusses environmental literacy, with ideas about how to clarify and redefine the term and how to answer questions such as: "What knowledge, skills, and attitudes are needed to be environmentally literate?" and "How can environmental literacy be assessed?" Write to ERIC Publications, 1200 Chambers Road, Room 310, Columbus, OH 43212.

Evaluating Environmental Education in Schools: A Practical Guide for Teachers by Dean Bennett (Unesco-UNEP, 1984). An introduction to evaluating an environmental education program in any school system. Part of the UNESCO International Environmental Education Programme.

A Guide to Curriculum Planning in Environmental Education by David Engleson (Wisconsin Department of Public Instruction, 1985). Designed to help identify content and instructional approaches for incorporating environmental education into local and state curricula. Available from the Wisconsin Department of Public Instruction, 125 South Webster Street, Post Office Box 7841, Madison, WI 53707.

Sourcebook in Environmental Education for Secondary School Teachers edited by R.C. Sharma and Merle C. Tan (Unesco Principal Regional Office for Asia and the Pacific, 1990). Provides a good overview of environmental issues and the pedagogical aspects of environmental education. Also contains sample lesson plans, assessment instruments, and worksheets. Written specifically for the Asia and Pacific region, but appropriate for worldwide audiences. Write to the Unesco Principal Regional Office for Asia and the Pacific, P.O. Box 967, Prakanong Post Office, Bangkok 10110, Thailand.

The Solid Waste Mess: What Should We Do With the Garbage? by Gloria Danziger (North American Association for Environmental Education, 1992). One volume in the Environmental Issues Forum (EIF) series designed to help local organizations and schools conduct public meetings and study circles addressing difficult environmental issues. Available from the North American Association for Environmental Education, Suite 400, 1255 23rd Street, NW, Washington, DC 20037.

GENERAL EDUCATION RESOURCES

Circle of Learning: Cooperation in the Classroom by David W. Johnson, Roger T. Johnson, Edythe Johnson Holubec, and Patricia Roy (Association for Supervision and Curriculum Development, 1984). Manual discusses the importance of cooperative learning and provides guidelines for implementing cooperative learning and teaching students cooperative skills. Addresses basic questions and myths about cooperative learning.

Civics for Democracy: A Journey for Teachers and Students by Katherine Isaac (Essential Books, 1992). Although written for U.S. audiences, includes a variety of ideas for citizenship activities, with a focus on individual action, public education, research, and citizen lobbying. For more information, write to the Center for Study of Responsive Law, P.O. Box 19367, Washington, DC 20036.

> *. . . you never miss the water till the well runs dry.*
>
> —Rowland Howard

Experiential Learning: Experience as the Source of Learning and Development by David A. Kolb (Prentice Hall, 1984). Gives the theoretical framework of the Experiential Learning Cycle.

> *Let us permit nature to have her way; she understands her business better than we do.*
>
> —Montaigne

Fulfilling the Promise: Biology Education in the Nation's Schools by the National Research Council (National Academy Press, 1990). Recommends content and teaching methodologies for elementary, middle, and upper school biology classes.

Interdisciplinary Curriculum: Design and Implementation edited by Heidi Hayes Jacobs (ASCD, 1989) Looks at different models for developing an integrated curriculum.

The 4MAT System: Teaching to Learning Styles with Left/Right Mode Techniques by Bernice McCarthy (Excel, 1980). Gives an overview of how 4MAT ties in with theories of educational psychology. Presents 4MAT lesson plans for all levels. Right brain/left brain theory is controversial.

4MAT and Science: Towards Wholeness in Science Education by Bob Samples, Bernice McCarthy, and Bill Hammond (Excel, 1985). Includes a variety of lesson plans that use the 4MAT system.

Science for All Americans by James Rutherford and Andrew Allgren (American Association for the Advancement of Science, 1990). Discusses the content that should be included in science curricula and how it should be taught. Covers many topics taught in environmental science programs. Available from the Oxford University Press, 200 Madison Ave., New York, NY 10016.

Science, Technology, and Society: A Framework for Curriculum Reform in Secondary School Science and Social Studies by Faith Hickman, John Patrick, and Rodger Bybee (Social Science Education Consortium, Inc., 1987). Provides suggestions and rationale for integrating science and social studies, including environmental issues.

Teaching Thinking: Readings from Educational Leadership edited by Ronald Brandt (ASCD, 1989). Includes a variety of articles from leading educators in the U.S. focusing on innovative strategies for teaching students how to improve thinking skills. Good overview of the field, with tips for measuring success, developing lesson plans, and integrating thinking skills into all subject areas. This book and a catalog listing a variety of educational publications are available from the Association for Supervision and Curriculum Development, 125 N. West Street, Alexandria, VA 22314.

The Unschooled Mind: How Children Think and How Schools Should Teach by Howard Gardener (Basic Books, 1991). Written by one of the premier educational researchers today, this challenging book describes how to make education more effective by better understanding how students' minds work. *Frames of Mind,* an earlier book by Gardener, introduces readers to his theory of multiple intelligences.Write to Basic Books, 10 E. 53rd St., New York, NY 10022.

AFRICAN WILDLIFE FOUNDATION. Provides financial and technical support to conservation and environmental education programs in Africa. International office in Nairobi, Kenya. For more information, write to 1717 Massachusetts Ave., NW, Washington, DC 20036.

THE ALLIANCE FOR ENVIRONMENTAL EDUCATION (AEE). A national environmental education organization that is working to build a national and international network of environmental education centers to promote teacher training, curriculum development, and resource sharing. For more information, write to AEE, P.O. Box 368, The Plains, VA 22171-0368.

THE CENTRE FOR ENVIRONMENT EDUCATION. Supports a wide variety of environmental education programs, including environmental education activity guides, newsletters, video projects, teacher training, and regional workshops. Write to Thaltej Tekra, Ahmedabad, India 380-054.

CONSERVATION INTERNATIONAL. Provides financial and technical support to help preserve tropical and temperate ecosystems. Primarily active in Central and South America, but expanding into Africa, Asia, and the Pacific. Write to 1015 18th Street, NW, Suite 1000, Washington, DC 20036.

ENVIRONMENTAL DEFENSE FUND. Focuses on the links between science, economics, and law to address environmental problems. Write to 257 Park Avenue South, New York, NY 10010.

THE ENVIRONMENTAL PROTECTION AGENCY (EPA). A large U.S. government agency, with ten regional offices, that oversees development and enforcement of environmental regulations. Produces a variety of environmental publications on topics ranging from pollution prevention to solid waste. For a catalog of materials, write to EPA, 401 M Street, SW, Washington, DC 20460. For information about environmental education, contact the Office of Environmental Education in the West Tower.

NATIONAL COALITION AGAINST THE MISUSE OF PESTICIDES. Publishes information about safer alternatives to toxic pesticides. Write to 701 E Street, SE, Suite 200, Washington, DC 20003.

THE NATURE CONSERVANCY. Provides financial and technical support to preserve biodiversity in Mesoamerica, South America, and the Caribbean. For more information, write to 1815 North Lynn St., Arlington, VA 22209.

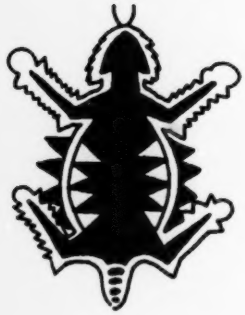
NEW YORK ZOOLOGICAL SOCIETY. Supports a wide range of projects dedicated to preserving biodiversity throughout the world. Write to 185th St. and Southern Blvd., Bronx, New York 10460.

NORTH AMERICAN ASSOCIATION FOR ENVIRONMENTAL EDUCATION (NAAEE), 1255 24rd Street, Washington, DC 20007. The largest association of environmental education professionals in the world. Publishes a variety of innovative environmental education materials and

The value of biodiversity is more than the sum of its parts.
—Bryan Norton

holds an annual conference for national and international environmental educators. For information on publications, activities, and membership, write to NAAEE, P.O. Box 400, Troy, OH 45373.

WORLD RESOURCES INSTITUTE (WRI) A research and policy institute helping governments, the private sector, environmental and development organizations, and others address the question of how societies can meet human needs and nurture economic growth while preserving the natural resources and environmental integrity on which life and economic vitality ultimately depend. For a listing of environmental education materials, books, reports, papers, briefings, seminars, and conferences, write to WRI, 1709 New York Avenue, NW, Washington, DC 20006.



WORLD WILDLIFE FUND/UK (WWF/UK), Education Department, Panda House, Weyside Park, Catteshall Lane, Godlaming, Surrey GU7 1XR, England. Produces a broad range of educational resources, including books, posters, videos, teaching packs, and educational kits, for all ages and subjects. Most of these materials have been produced for use in the United Kingdom, but can be adapted for use in other countries. To request a catalog or to order resources, write to: WWF UK, Educational Distribution, PO Box 963, Slough SL2 3RS England.

WORLD WILDLIFE FUND/US (WWF/US). The largest private organization in the U.S. providing financial and technical support to efforts that encourage the conservation of natural resources and the protection of worldwide biodiversity. WWF supports programs in more than 60 countries. For information about specific activities and publications, write to WWF, 1250 24th Street, NW, Washington, DC 20007.

ZERO POPULATION GROWTH (ZPG), INC. A national non-profit membership organization that works to mobilize broad public support for population stabilization in the U.S. and worldwide. Write to 1400 16th Street, NW, Suite 320, Washington, DC 20036 for a catalog of publications and resources.

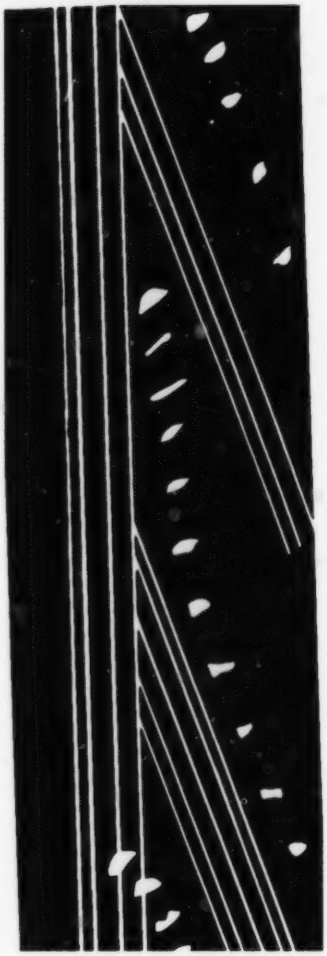
PEACE CORPS EDUCATION LEARNING RESOURCES

THE GROWING CLASSROOM: GARDEN-BASED SCIENCE by Roberta Jaffe and Gary Appel (Addison-Wesley Publishing Co., 1990). Provides ideas for teachers who want to develop a garden-based science program. Offers information for starting a school garden, incorporating activities into classroom curricula, and adapting the program to meet specific needs and resources. Order from the Whole Ice Catalog, No. AG237.

NONFORMAL EDUCATION MANUAL by Helen Fox (Peace Corps, 1989). Great introduction to nonformal education, with chapters focusing on the definition of nonformal education, how adults learn, helping people identify their needs, planning, evaluation, nonformal techniques for working with groups, and developing nonformal materials from local resources. Many of the topics and activities directly related to formal and nonformal environmental education. Order from the Whole Ice Catalog, No. M-42.

PARTICIPATORY RURAL APPRAISAL HANDBOOK published by the Center for International Development and Environment of the World Resources Institute (World Resources Institute, 1990). Includes strategies for community assessments and project planning. Can be adapted for environmental community assessments. Order from the Whole Ice Catalog.

CONSERVATION EDUCATION: A PLANNING GUIDE by Dave and Diane Wood (Peace Corps, 1987). Companion to this book. Includes strategies for developing a successful environmental education program. Chapters focus on assessing the community, defining environmental problems, evaluating solutions, identifying target audiences, defining the messages, selecting an appropriate education strategy, and evaluating the program. Order from the Whole Ice Catalog, No. M-23.



TEACHER TRAINING, A REFERENCE MANUAL by the Center for International Education (Peace Corps, 1986). Includes tips and tricks for teacher trainers, with chapters focusing on adult learning, how to design a training program, training techniques, approaches to teaching, how to write objectives, classroom management, and student assessment. Order from the Whole Ice Catalog, No. T-45.

TEACHER TRAINING, A TRAINING GUIDE by the Center for International Education (Peace Corps, 1986). Companion volume to the Teacher Training Reference Manual described above. Includes training sessions that relate to sections in the Reference Manual and is designed to help Peace Corps teacher trainers with suggestions for how to train others. Order from the Whole Ice Catalog, No. T-46.

TEACHING CONSERVATION IN DEVELOPING NATIONS by Judith Brace, co-sponsored by the National Audubon Society and Peace Corps (Peace Corps, 1982). A working tool for Peace Corps Volunteers and other development workers who want to incorporate conservation education into their day-to-day community activities. Includes suggestions for building a nature trail, constructing exhibits, landscaping, incorporating conservation education into health and agricultural programs, and using live animals. Order from the Whole Ice Catalog, No. M-7.

TEACHING ENGLISH AS A FOREIGN LANGUAGE TO LARGE, MULTI-LEVEL CLASSES edited by Mary Jo Larson (Peace Corps, 1993). A wealth of ideas and suggestions for how to design innovative lesson plans, use cooperative learning effectively, assess student performance, manage large classes, and build local capacity. Order from the Whole Ice Catalog, No. M-46.

SECONDARY PROJECTS by the Education Sector, Office of Training and Program Support (Peace Corps, 1987). Strategies to help Education Peace Corps Volunteers take on community projects in addition to their primary job assignment. Includes information about identifying projects and planning, implementing, evaluating, and documenting them. Also includes case studies. Order from the Whole Ice Catalog, No. M-36.

BIOLOGICAL SUPPLY COMPANIES

CAROLINA BIOLOGICAL SUPPLY COMPANY, 2700 York Road, Burlington, NC 27215.

DELTA EDUCATION, P.O. Box 915, Hudson, NH 03051.

WARD'S NATURAL SCIENCE ESTABLISHMENT, INC., 5100 West Henrietta Road, P.O. Box 92912, Rochester, NY 14692.

WHERE TO GET MORE INFORMATION

- International environmental organizations that have offices in your country, such as World Wildlife Fund, Nature Conservancy, and Conservation International
- Local natural history museums, arboretums, and botanical gardens.
- Local, regional, and national parks and protected areas, especially those sites that have educational centers and interpretive programs
- Local and regional extension offices
- Ministries of Education, Natural Resources, Forestry, Agriculture, and/or the Environment
- Non-governmental organizations (NGOs) that focus on environmental and conservation issues
- Teacher training colleges and curriculum development units
- University departments of biology, botany, conservation, forestry, education, and teacher training

ADDITIONAL RESOURCES USED FOR THIS MANUAL

ASSESSMENT OF LEARNING OUTCOMES IN ENVIRONMENTAL EDUCATION by Louis A. Iozzi, Dany Laveault, and Thomas Marcinkowski (UNESCO, 1990).

A COMPARATIVE SURVEY OF THE INCORPORATION OF ENVIRONMENTAL EDUCATION INTO SCHOOL CURRICULA (Unesco Institute for Education, 1986).

CRITICAL THINKING HANDBOOK: HIGH SCHOOL—A GUIDE FOR REDESIGNING INSTRUCTION by Richard Paul, A.J.A. Binker, Douglas Martin (Center for Critical Thinking and Moral Critique, 1989).

DEVELOPING MINDS: A RESOURCE BOOK FOR TEACHING THINKING edited by Arthur L. Costa (Association for Supervision and Curriculum Development, 1985).

A DICTIONARY OF ENVIRONMENTAL QUOTATIONS by Barbara K. Rodes and Rice Odell (Simon and Schuster, 1992).

EDUCATION AND LEARNING TO THINK by Lauren Resnick (National Academy Press, 1987).

ENVIRONMENTAL EDUCATION ACTIVITIES MANUAL by William Stapp and Dorothy A. Cox (Bill Stapp, 1981).

Environmental Education Guidelines for Washington Schools by Dr. Frank B. Brouillet (Division of Instructional Programs and Services, Office of the Superintendent of Public Instruction, 1988).

Environmental Education: Module for In-Service Training of Teachers and Supevisors for Primary Schools prepared by the National Council of Educational Research and Training, New Delhi, India (UNESCO-UNEP,1985).

Environmental Education Report to Congress by John Disinger, 1993. Draft. Report commissioned by Office of Environmental Education, EPA, with direction from NAAEE.

Essentials of Learning for Instruction by Robert Gagne and Marcy Perkins Driscoll (Prentice Hall, 1988).

Frames of Mind by Howard Gardener (Basic Books, Inc., 1985).

Global Education: From Thought to Action edited by Kennth A. Tye (Association for Supervision and Curriculum Development, 1990).

Handbook I: Cognitive Domain by Benjamin Bloom (David McKay Company, Inc., 1956).

Humanizing Environmental Education: A Guide for Learning Nature and Human Nature Activities by Clifford E. Knapp and Joel Goodman (American Camping Association, 1983).

Informal Assessment in Education by Gilbert Guerin (Mayfield Publishing Company, 1983).

Investigating and Evaluating Environmental Issues and Actions: Skill Development Modules. A Curriculum Development Project Designed to Teach Students How to Investigate and Evaluate Science-Related Social Issues by Harold Hungerford, Ralph Litherland, Ben Peyton, John Ramsey, Audrey Tomera, and Trudi Volk (Stipes Publishing Co., 1985).

An Introduction to Theories of Learning by B. R. Hergenhahn (Prentice Hall, Inc., 1982).

Making Instruction Work by Robert F. Mager (Lake Publishing Company, 1988).

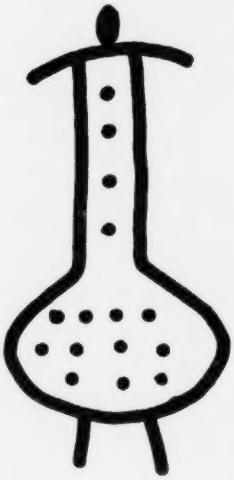
Nature Writing edited by Robert Finch and John Elder (W. W, Norton & Company, 1990).

Plan-O-Gram by the American Planning Association, 1776 Massachusetts Avenue, NW, Washington, DC 20036.

Psychology, Teaching, Learning, and Growth by Don Hamachek (Simon and Schuster, 1990).

Science, Technology, and Society: A Framework for Curriculum Reform in Secondary School Science and Social Studies by Faith Hickman, John Patrick, and Rodger Bybee (Social Science Education Consortium, Inc., 1987).

> *Nature has been for me, for as long as I can remember, a source of solace, inspiration, adventure, and delights; a home, a teacher, a companion.*
>
> —Lorraine Anderson



STRATEGIES FOR THE TRAINING OF TEACHERS IN ENVIRONMENTAL EDUCATION by Richard Wilke, Ben Peyton, and Harold Hungerford (UNESCO-UNEP, 1987).

THE TBILISI DECLARATION published in Connect (UNESCO, Vol. III, No. 1, January 1978, p. 1-7).

TRENDS AND ISSUES RELATED TO THE PREPARATION OF TEACHERS FOR ENVIRONMENTAL EDUCATION: ENVIRONMENTAL EDUCATION INFORMATION REPORT by John Disinger and Robert Howe (The ERIC Clearinghouse, 1990).

VALUES AND TEACHING: WORKING WITH VALUES IN THE CLASSROOM by Louis Raths, Merril Harmin, and Sidney Simon (Charles E. Merrill Publishing Co., 1978).

VALUES, CURRICULUM, AND THE ELEMENTARY SCHOOL by Alexander Frazier (Houghton Mifflin Company, 1980).

WRITE SOURCE 2000: A NEW DIRECTION IN WRITING AND LEARNING (Write Source Education Publishing House, 1990).

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We don't see things as they are;
we see them as we are.
—Anais Nin

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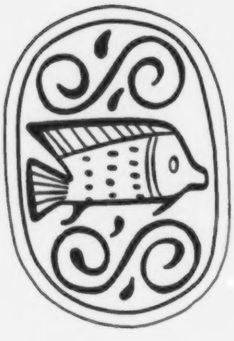

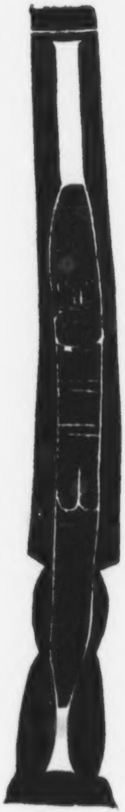

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ABOUT THE AUTHORS

Judy Braus has been actively involved in national and international environmental education efforts for almost twenty years. She is currently the Director of Environmental Education for the World Wildlife Fund (WWF) and a board member of the North American Association for Environmental Education. Before coming to WWF, Judy coordinated Peace Corps' environmental education activities and conducted workshops, assessments, evaluations, and programming activities in all four regions: Africa, Latin America, Eurasia and the Middle East, and Asia/Pacific. Prior to her Peace Corps service, Judy was the Director of School Programs at the National Wildlife Federation (NWF) and the editor of NatureScope*—an environmental education activity series for educators. She was also a Senior Editor on* Ranger Rick, *NWF's children's magazine, and has written several children's books. Judy has also worked as a park naturalist in Ohio and Maryland and as a reporter/lobbyist on Capitol Hill.*

David Wood has helped develop programs and present workshops in environmental education in Africa, Asia, Eastern Europe, and Central and South America. He and his wife, Diane, served as Peace Corps Volunteers working as environmental education specialists with the Paraguayan National Forest Service from 1977 to 1981. Together, they co-authored ICE manual M-23, Conservation Education: A Planning Guide. *Awarded a National Presidential Award for Excellence in Science Teaching, David teaches eighth grade environmental science at Sidwell Friends School in Washington, D.C. and continues to work with international environmental education projects.*